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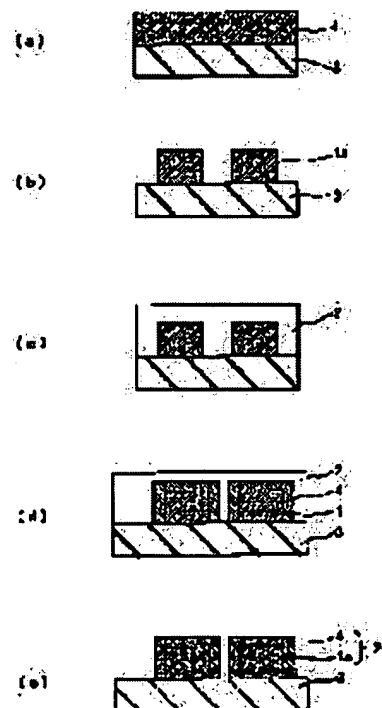
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## (54) FINE PATTERN FORMING MATERIAL, MANUFACTURE OF SEMICONDUCTOR DEVICE USING SAME, AND SEMICONDUCTOR DEVICE

(57)Abstract:

**PROBLEM TO BE SOLVED:** To perform a pattern formation exceeding the wavelength limit in fining of a separating pattern or hole pattern by using a fine pattern forming material which mainly contains a water-soluble resin, a mixture of water-soluble resins, or a copolymer of water-soluble resins, and causes a crosslinking reaction in the presence of acid.

**SOLUTION:** A fine pattern forming material which mainly contains one water-soluble resin, a mixture of two or more of water-soluble resins, or a copolymer of two or more of water-soluble resins, and causes a crosslinking reaction in the presence of acid is used. In the manufacture of a semiconductor device, a resist pattern 1a containing a material generating acid by exposure is covered with a resist 2 containing a material crosslinked in the presence of acid. The acid is generated in the resist pattern 1a by heating or exposure, and a crosslinked layer 4 generated on the interface is formed as the covering layer of the resist pattern 1a to thicken the resist pattern 1a. Thus, the resist hole diameter and the separating width can be reduced.



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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] In a semi-conductor process, in case this invention forms a resist pattern, it relates to the formation approach of the ingredient for detailed separation resist patterns which reduces the separation size or hole opening size of a pattern, and the detailed separation pattern using it, the manufacture approach of the semiconductor device using this detailed separation resist pattern further, and the semiconductor device manufactured by this manufacture approach.

[0002]

[Description of the Prior Art] Wiring and separation width of face which are required of a manufacture process are made detailed very much with high integration of a semiconductor device. Generally, formation of a detailed pattern forms a resist pattern with a photolithography technique, and is performed by the approach of etching the various thin films of a substrate by using the formed resist pattern as a mask after that.

[0003] Therefore, in formation of a detailed pattern, a photolithography technique becomes very important. The photolithography technique consists of resist spreading, mask alignment, exposure, and development, and the limitation has produced it from constraint of exposure wavelength in detailed-ization to detailed-izing. Furthermore, it was difficult to control the etching-proof nature of a resist by the conventional lithography process, and it was impossible to have controlled the shape of surface type, such as to carry out surface roughening of the pattern side-attachment-wall front face after etching, by control of etching-proof nature.

[0004]

[Problem(s) to be Solved by the Invention] As explained above, formation of the detailed resist pattern which exceeds the limitation of the wavelength with the photolithography technique by the conventional exposure was difficult. This invention offers the detailed separation resist pattern formation technique using this, and offers the technique to which control carries out surface roughening of the shape of pattern side-attachment-wall surface type after difficult etching with the conventional lithography technique in detailed-izing of a separation pattern and a hole pattern while it offers the water-soluble ingredient which does not dissolve the substrate resist which realizes detailed separation resist pattern formation which makes pattern formation exceeding a wavelength limitation possible. Furthermore the manufacture approach of the semiconductor device using that detailed separation resist pattern formation technique tends to be offered, and it is going to offer the semiconductor device manufactured by this manufacture approach.

[0005]

[Means for Solving the Problem] The detailed pattern formation ingredient of this invention uses one kind of water soluble resin, or two kinds or more of said water soluble resin of mixture, or the copolymerization object by two or more kinds of said water soluble resin as a principal component, and is characterized by producing crosslinking reaction by existence of an acid.

[0006] Moreover, the detailed pattern formation ingredient of this invention is characterized by using

one kind in polyacrylic acid, a polyvinyl acetal, a polyvinyl pyrrolidone, polyvinyl alcohol, polyethyleneimine, polyethylene oxide, a styrene maleic anhydride copolymer, a polyvinyl amine, the poly allylamine, oxazoline radical content water soluble resin, water-soluble melamine resin, a water-soluble urea-resin, an alkyd resin, and a sulfonamide, or these two kinds or more of mixture, or these salts as a principal component as said water soluble resin.

[0007] Moreover, the detailed pattern formation ingredient of this invention uses one kind of a water-soluble cross linking agent, or two kinds or more of said water-soluble cross linking agent of mixture as a principal component, and is characterized by producing crosslinking reaction by existence of an acid. Moreover, the detailed pattern formation ingredient of this invention is characterized by using one kind or these two kinds or more of mixture of a melamine derivative, a urea derivative, benzoguanamine, and the glycoluryl as a principal component as said water-soluble cross linking agent.

[0008] Moreover, the detailed pattern formation ingredient of this invention is characterized by using one kind or such mixture of a melamine and the alkoxy methylene melamines as a principal component as said melamine derivative. Moreover, the detailed pattern formation ingredient of this invention is characterized by using one kind or these two kinds or more of mixture of a urea, alkoxy methyleneurea, N-alkoxy methyleneurea, an ethylene urea, and an ethylene urea carboxylic acid as a principal component as said urea derivative.

[0009] Moreover, the detailed pattern formation ingredient of this invention uses one kind of water soluble resin or two kinds or more, one kind of a water-soluble cross linking agent, or two kinds or more of mixture as a principal component, and is characterized by producing crosslinking reaction by existence of an acid. Moreover, the detailed pattern formation ingredient of this invention is characterized by using either of the mixture of a melamine derivative, a urea derivative or a melamine derivative, and a urea derivative as said water-soluble cross linking agent, using either of the mixture of a polyvinyl acetal, polyvinyl alcohol or polyvinyl alcohol, and a polyvinyl acetal as said water soluble resin.

[0010] Moreover, the detailed pattern formation ingredient of this invention is characterized by including a plasticizer as an additive. Moreover, the detailed pattern formation ingredient of this invention is characterized by including a surfactant as an additive.

[0011] Next, the process in which the manufacture approach of the semiconductor device this invention forms the 1st resist pattern which may generate an acid on a semi-conductor base material by the 1st resist, The process which forms the 2nd resist which causes crosslinking reaction by existence of an acid on said 1st resist pattern, Down stream processing which forms the bridge formation film in the part which touches said 1st resist pattern of said 2nd resist by supply of the acid from said 1st resist pattern, It is characterized by including the process which exfoliates the part of said 2nd resist non-constructing a bridge, and forms the 2nd resist pattern, and the process which etches said semi-conductor base material by using this 2nd resist pattern as a mask.

[0012] Moreover, the manufacture approach of the semiconductor device this invention is characterized by forming said 1st resist pattern by the resist which generates an acid by heat-treatment. Moreover, the manufacture approach of the semiconductor device this invention is characterized by forming said 1st resist pattern by the resist which generates an acid by exposure.

[0013] Moreover, the manufacture approach of the semiconductor device this invention is characterized by forming said 1st resist pattern by the resist containing an acid. Moreover, the manufacture approach of the semiconductor device this invention is characterized by forming said 1st resist pattern by the resist which performed surface preparation by the acid liquid or acid gases.

[0014] Moreover, the manufacture approach of the semiconductor device this invention is characterized by using the resist which uses novolak resin and mixture of a naphthoquinonediazide system sensitization agent as a principal component as said 1st resist. Moreover, the manufacture approach of the semiconductor device this invention is characterized by using the chemistry magnification mold resist which has the device in which an acid is generated, as said 1st resist.

[0015] Moreover, the manufacture approach of the semiconductor device this invention is characterized by using said detailed pattern formation ingredient according to claim 1 to 11 as said 2nd resist.

Moreover, the manufacture approach of the semiconductor device this invention is characterized by controlling reacting weight with said 1st resist by adjusting the amount of mixing of said water soluble resin and said water-soluble cross linking agent, using said detailed pattern formation ingredient according to claim 7 as said 2nd resist.

[0016] Moreover, the manufacture approach of the semiconductor device this invention is characterized by controlling reacting weight with said 1st resist by adjusting the degree of acetalization of said polyvinyl acetal, using said detailed pattern formation ingredient according to claim 8 or 9 as the 2nd resist. Moreover, the manufacture approach of the semiconductor device this invention is characterized by using water or a water-soluble mixed solvent as a solvent of said 2nd resist.

[0017] Moreover, the manufacture approach of the semiconductor device this invention is characterized by forming said bridge formation film in contact with the front face of said 1st resist pattern by heat-treating said 1st resist pattern and said 2nd resist formed on said 1st resist pattern. Moreover, the manufacture approach of the semiconductor device this invention is characterized by forming said bridge formation film in said predetermined field of said 1st resist pattern by exposing a predetermined field from on said 2nd resist formed on said 1st resist pattern and said 1st resist pattern.

[0018] Moreover, the manufacture approach of the semiconductor device this invention carries out electron beam irradiation of except for the predetermined field of said 1st resist pattern, and is characterized by forming said 2nd resist on this 1st resist pattern by which electron beam irradiation was carried out, and forming said bridge formation film in said predetermined field of said 1st resist pattern. Moreover, the semiconductor device of this invention is characterized by manufacturing by the manufacture approach of each aforementioned semiconductor device.

[0019]

#### [Embodiment of the Invention]

Gestalt 1. drawing 1 of operation is drawing showing the example of the mask pattern for forming the target resist pattern by which detailed separation was carried out by this invention, in drawing 1 (a), the mask pattern 100 of a detailed hole and drawing 1 (b) show the mask pattern 200 of a detailed tooth space, and drawing 1 (c) shows the pattern 300 of the remnants of isolation. Drawing 2 - drawing 7 are the process-flow Figs. for explaining the detailed separation resist pattern formation approach of the gestalt 1 implementation this invention.

[0020] First, the detailed separation resist pattern formation approach of the gestalt this operation and the manufacture approach of the semiconductor device using this are explained, referring to drawing 1 and drawing 2. First, as drawing 2 (a) shows, the 1st resist 1 which has the device in which an acid is generated inside by suitable heat-treatment in the semi-conductor substrate (semi-conductor wafer) 3 is applied (about 0.7-1.0 micrometers in for example, thickness). This 1st resist 1 is applied with a spin coat etc. on the semi-conductor substrate 3, next gives Puri \*\* -KU (it is heat treatment for about 1 minute at 70-110 degrees C), and evaporates the solvent in the 1st resist 1.

[0021] Next, in order to form the 1st resist pattern, g line, i line or Deep-UV, a KrF excimer, an ArF excimer, EB (electron ray), X-ray, etc. carry out projection exposure using the mask containing a pattern as shown in drawing 1 using the light source corresponding to the sensibility wavelength of the 1st applied resist 1.

[0022] Either a positive type or negative resist is [ that what is necessary is just a resist using the device which an acidic component generates inside a resist by suitable heat-treatment ] OK as the ingredient of the 1st resist 1 used here. For example, as the 1st resist, the positive resist which consists of novolak resin and a naphthoquinonediazide system sensitization agent is mentioned. Furthermore, as the 1st resist, application of the chemistry magnification mold resist using the device in which an acid is generated may also be possible, and other things may be used as long as it is a resist ingredient using the system of reaction which generates an acid with heating.

[0023] After exposing the 1st resist 1, if needed, PEB (exposure afterbaking) is performed (for example, PEB temperature: 50-130 degrees C), and the resolution of a resist 1 is raised. Next, negatives are developed using about 0.05 to 3.0 wt% [ , such as TMAH (tetramethylammonium hydroxide), ] alkali water bath liquid. Drawing 2 (b) shows 1st resist pattern 1a formed in this way.

[0024] After performing a development, postdeveloping BEKU may be performed if needed (baking temperature is 60-120 degrees C and about 60 seconds). Since this heat treatment influences a next mixing reaction, it is desirable to combine with the 1st resist to be used or the 2nd resist ingredient, and to set it as suitable temperature. The above is the same as that of formation of the resist pattern by the general resist process as a process, if the point of using the 1st resist 1 which generates an acid is set aside.

[0025] Next, as shown in drawing 2 (c), the ingredient of cross-linking which constructs a bridge by existence of an acid on the semi-conductor substrate 1 is used as a principal component, and the 2nd resist 2 dissolved in the solvent which does not dissolve the resist 1 of drawing 1 is applied. If spreading to homogeneity is possible for the method of application of the 2nd resist 2 on 1st resist pattern 1a, it can also be applied by not being limited especially and immersed into spreading by the spray, rotation spreading, or the 2nd resist solution (dipping). Next, this is prebaked after spreading of the 2nd resist 2 if needed (for example, 85 degrees C, about 60 seconds), and the 2nd resist layer 2 is formed.

[0026] Next, as shown in drawing 2 (d), 1st resist pattern 1a formed in the semi-conductor substrate 1 and the 2nd resist 2 formed on this are heat-treated (it is written as MB mixing BEKU and if needed [ following ].). 85 degrees C - 150 degrees C whenever [ stoving temperature ] is carried out, for example, diffusion of an acid is promoted from the 1st resist pattern 1a, it supplies into the 2nd resist 2, and crosslinking reaction is generated in the interface of the 2nd resist 2 and 1st resist pattern 1a. What is necessary is for the mixing baking temperature / time amount in this case to be 85 degree-C-150 degree-C/60-120sec(s), and just to set it as the optimal conditions with the class of resist ingredient to be used, and the thickness of the reaction layer to need. It is formed into the 2nd resist 2 so that the bridge formation layer 4 which caused crosslinking reaction may cover 1st resist pattern 1a with this mixing BEKU.

[0027] Next, as shown in drawing 2 (e), development exfoliation of the 2nd resist 2 which is not constructing a bridge is carried out using the developer of alkali water solutions, such as water or TMAH, and 2nd resist pattern 2a is formed. It becomes possible to obtain the resist pattern to which the hole bore of a hole pattern or the separation width of face of the Rhine pattern was reduced, or the area of an isolated remnants pattern was expanded by the above processing. \*\*.

[0028] In the above, by the formation approach of the detailed resist pattern explained with reference to drawing 2, after forming the 2nd resist layer 2 on 1st resist pattern 1a, the acid was generated in 1st resist pattern 1a by suitable heat-treatment, and how to diffuse to the 2nd resist 2 was explained. Below, instead of this heat-treatment, how to make an acid emit by exposure is explained in advance of heat-treatment. Drawing 3 is a process-flow Fig. for explaining the formation approach of the detailed separation resist pattern in this case. First, since the process of drawing 3 (a) - (c) is the same as that of drawing 2 (a) - (c), it omits explanation. In addition, as the 1st resist 1, application of the chemistry magnification mold resist using the device in which an acid is generated by exposure is also possible in this case. In a chemistry magnification mold resist, the magnification reaction which the generation reaction of the acid catalyst by light, an electron ray, an X-ray, etc. occurs, and is triggered by the catalyst of the generated acid is used.

[0029] Next, as shown in drawing 3 (d), the semi-conductor substrate 1 is again exposed completely by g line or i line of Hg lamp, an acid is generated in 1st resist pattern 1a, and after forming the 2nd resist layer 2 shown by drawing 3 (c), this forms the bridge formation layer 4 near the interface of the 2nd resist 2 which touches 1st resist pattern 1a, as shown in drawing 3 (e).

[0030] What is necessary is the light source used for the exposure at this time to be possible also for using Hg lamp, a KrF excimer, an ArF excimer, etc., and not to be limited by exposure especially if generating of an acid is possible for it, and just to expose it using the light source and light exposure according to the sensitization wavelength of the 1st used resist 1 according to the sensitization wavelength of the 1st resist 1.

[0031] Thus, it exposes after spreading of the 2nd resist 2, and an acid is generated in 1st resist pattern 1a, and by adjustment of light exposure, since the amount of the acid generated in 1st resist pattern 1a in order to expose 1st resist pattern 1a in the condition of having been covered with the 2nd resist 2 is

correctly controllable in the large range, the thickness of the reaction layer 4 can control it with a sufficient precision by the example of drawing 3.

[0032] Next, the semi-conductor substrate 1 is heat-treated if needed (for example, 60-130 degrees C, mixing BEKU). By this, the acid from the 1st resist pattern 1a is diffused, it supplies into the 2nd resist 2, and crosslinking reaction is promoted in the interface of the 2nd resist 2 and 1st resist pattern 1a.

What is necessary is for the mixing baking temperature / time amount in this case to be 60-130 degree-C/60-120sec(s), and just to set it as the optimal conditions with the class of resist ingredient to be used, and the thickness of the reaction layer to need. It is formed into the 2nd resist 2 so that the bridge formation layer 4 which caused crosslinking reaction may cover 1st resist pattern 1a with this mixing BEKU.

[0033] Next, the process of drawing 3 (f) is the same as that of drawing 2 (e). It becomes possible to obtain the resist pattern to which a hole bore or the separation width of face of the Rhine pattern was reduced, or the area of an isolated remnants pattern was expanded by the above processing.

[0034] In addition, like the example of the approach explained with reference to drawing 3, the process which generates an acid component in 1st resist pattern 1a by exposure is suitable, when the 1st resist 1 and 2nd resist 2 to apply have comparatively low reactivity, when the thickness of the bridge formation layer to need is comparatively thick, or especially when equalizing crosslinking reaction.

[0035] Here, the ingredient used for the 2nd resist 2 is explained. As the 2nd resist, the independence of the water soluble resin of cross-linking or two or more kinds of those mixture can be used. Moreover, the independence of a water-soluble cross linking agent or two or more kinds of those mixture are used. Furthermore, the mixture of these water soluble resin and a water-soluble cross linking agent is used. When using mixture as the 2nd resist, those ingredient presentations are not limited by the 1st resist ingredient to apply or the set-up reaction condition that what is necessary is just to especially set up the optimal presentation.

[0036] As an example of the water-soluble-resin constituent used for the 2nd resist Polyacrylic acid as shown in drawing 4, a polyvinyl acetal, a polyvinyl pyrrolidone, Polyvinyl alcohol, polyethyleneimine, polyethylene oxide, A styrene-maleic-acid copolymer, polyvinyl amineresin, the poly allylamine, Oxazoline radical content water soluble resin, water-soluble melamine resin, a water-soluble urea-resin, If a water-soluble cross linking agent and mixing are possible when an alkyd resin, sulfonamide resin, etc. can apply effectively, crosslinking reaction is produced under acidic component existence or it does not produce crosslinking reaction, it will not be limited especially. Moreover, it is effective even if it uses these independently, and it uses as mixture.

[0037] You may use as one kind or two kinds or more of mixture, and these water soluble resin can be suitably adjusted by reacting weight with the 1st resist 1 of a substrate, a reaction condition, etc. Moreover, it is the purpose which raises the solubility to water, and you may use by making these water soluble resin into salts, such as a hydrochloride.

[0038] Next, specifically as a water-soluble cross linking agent which can be used for the 2nd resist, amino system cross linking agents, such as melamine system cross linking agents, such as urea system cross linking agents, such as a urea as shown in drawing 5, alkoxy methyleneurea, N-alkoxy methyleneurea, an ethylene urea, and an ethylene urea carboxylic acid, a melamine, and an alkoxy methylene melamine, benzoguanamine, and glycoluryl, etc. are applicable. However, it will not be limited especially if it is the water-soluble cross linking agent which produces bridge formation not with the thing limited to especially an amino system cross linking agent but with an acid.

[0039] As a water-soluble concrete resist ingredient furthermore used for the 2nd resist, it is effective independent or independent or to also mix and use [ of water soluble resin which was mentioned above / of a water-soluble cross linking agent which was similarly mentioned above into mixture ] mixture mutually. For example, specifically, mixing and using a methoxy methylol melamine or an ethylene urea as a water-soluble cross linking agent as the 2nd resist, using polyvinyl-acetal resin as a water-soluble-resin constituent etc. is mentioned. In this case, since water solubility is high, the preservation stability of a mixed solution is excellent. In addition, it will not be limited especially if it is the ingredient which is meltable to water solubility or the water-soluble solvent which does not dissolve the 1st resist pattern

as for the ingredient applied to the 2nd resist, and produces crosslinking reaction under existence of an acid component.

[0040] In addition, although it is as having explained previously that acid generating by the re-exposure to 1st resist pattern 1a is not performed, but crosslinking reaction can be realized only by heat-treatment, it is desirable to choose a suitable reactant high ingredient as the 2nd resist 2 in this case, and to perform suitable heat-treatment (for example, 85 degrees C - 150 degrees C). It is effective to specifically use for polyvinyl-acetal resin an ethylene urea, polyvinyl alcohol and an ethylene urea, or the water-soluble ingredient constituent that mixed these at a suitable rate as 2nd resist ingredient in this case.

[0041] Next, in this invention, it is important to control the crosslinking reaction of the 1st resist 1 and the 2nd resist 2, and to control the thickness of the bridge formation layer 4 formed on 1st resist pattern 1a. As for control of crosslinking reaction, it is desirable to optimize according to the reactivity of the 1st resist 1 and the 2nd resist 2 to apply, the configuration of 1st resist pattern 1a, the thickness of the crosslinking reaction layer 4 to need, etc.

[0042] Control of the crosslinking reaction of the 1st resist and the 2nd resist has the technique by adjustment of process conditions, and the technique of adjusting the presentation of the 2nd resist ingredient. as the process control technique of crosslinking reaction -- (1) -- the technique of adjusting (2) MB (mixing BEKU) temperature and the processing time which adjust the light exposure to 1st resist pattern 1a is effective. Especially, it heats, and by adjusting the time amount (MB time amount) which constructs a bridge, it is possible to control the thickness of a bridge formation layer, and it can be called the technique in which a reaction controllability is very high. Moreover, the technique of controlling reacting weight with the 1st resist from the field of the ingredient presentation used for the 2nd resist by mixing the suitable, water-soluble cross linking agent for (3) (4) which controls reacting weight with 1st resist by mixing two or more kinds of suitable water soluble resin, and adjusting the mixing ratio water soluble resin, and adjusting the mixing ratio is effective.

[0043] the thickness of the bridge formation layer which does not opt for control of such crosslinking reaction unitary, and (3) 3 [ the configuration of the reactivity of the 2nd resist ingredient and the 1st resist ingredient to apply, and the (1) (2) 1st resist pattern, thickness, and ] need and (4) -- it is necessary to take into consideration and determine conditions with various usable exposure conditions or MB conditions, (5) spreading conditions, etc. [ however, ] When, especially as for the reactivity of the 1st resist and the 2nd resist, the presentation of the 1st resist ingredient shows being influenced, therefore it actually applies this invention, it is desirable to take into consideration the factor mentioned above and to optimize the 2nd resist ingredient constituent. Therefore, especially the class and its presentation ratio of the water-soluble ingredient used for the 2nd resist are not limited, and are optimized and used according to the class of ingredient to be used, heat treatment conditions, etc.

[0044] In addition, plasticizers, such as ethylene glycol, a glycerol, and triethylene glycol, may be added to the 2nd resist ingredient with an additive. moreover, the 2nd resist ingredient -- being related -- a purpose [ top / membrane formation disposition ] -- carrying out -- the surfactant by 3M company, for example, Fluorad, and Mitsuhiro -- formation -- water-soluble surfactants, such as shrine NONIPORU, may be added as an additive.

[0045] Next, the solvent used for the 2nd resist is explained. Although it is required for the solvent used for the 2nd resist not to dissolve the pattern of the 1st resist and to fully dissolve a water-soluble ingredient further, it will not be limited especially if it is the solvent which fills this. For example, what is necessary is just to use the independence of water-soluble organic solvents, such as alcoholic solvent, such as water (pure water) or water, and IPA, or N-methyl pyrrolidone, or a mixed solution as a solvent of the 2nd resist.

[0046] What is necessary is it to be possible to use alcohols, such as ethanol, a methanol, and isopropyl alcohol, gamma-PUCHIRO lactone, an acetone, etc., and just to mix in the range which does not dissolve the 1st resist pattern as a solvent mixed in water, according to the solubility of the ingredient used for the 2nd resist, if it is water solubility, and it is not limited especially and an example is given.

[0047] Now, although the above example explained how to form a detailed resist pattern all over the semi-conductor substrate 1, how to form a detailed resist pattern alternatively only in the request field of



the semi-conductor substrate 1 next is explained. Drawing 6 R> 6 is the process-flow Fig. of the manufacture approach in this case. First, the process of drawing 6 (a) - (c) is the same as that of drawing 3 (a) - (c). Like drawing 6 (c), after forming the 2nd resist layer 2 next, as shown in drawing 6 (d), it shades with a gobo 5, some semi-conductor substrates 3 are again exposed by g line or i line of Hg lamp to the selected field, and an acid is generated in 1st resist pattern 1a. This forms the bridge formation layer 4 near the interface of the 2nd resist 2 which touches 1st resist pattern 1a in the exposed part, as shown in drawing 6 (e).

[0048] Since the process of subsequent drawing 6 (f) is the same as the process of drawing 3 (f), explanation is omitted. Thus, in the field in which the semi-conductor substrate 3 was chosen, the bridge formation layer 4 is formed on 1st resist pattern 1a, and it can avoid forming a bridge formation layer in the 1st resist pattern in other fields, as shown in drawing 6 (f). According to such a formation approach, by using a suitable exposure mask, it can expose alternatively on the semi-conductor substrate 1, an exposure part and an unexposed part can be distinguished, and the 2nd resist pattern can form the field which constructs a bridge in a boundary part with the 1st resist pattern, and the field which does not construct a bridge. Thereby, the detailed hole or detailed tooth space of a different dimension on the same semi-conductor substrate can be formed.

[0049] Drawing 7 is the process-flow Fig. of other formation approaches for forming a detailed resist pattern alternatively only in the request field of the semi-conductor substrate 1. First, the process of drawing 7 (a) - (c) is the same as that of drawing 2 (a) - (c). Like drawing 7 R> 7 (c), after forming the 2nd resist layer 2 next, as shown in drawing 7 (d), the field where the semi-conductor substrate 3 was chosen is covered with the electron ray shield 6, and an electron ray is irradiated to other fields. Next, if it heat-treats at the process of drawing 7 (e), a bridge formation layer will not be formed in the field which irradiated the electron ray, but a bridge formation layer will be formed only in the predetermined field which covered electron beam irradiation.

[0050] Since the process of subsequent drawing 7 (f) is the same as the process of drawing 2 (f), explanation is omitted. Thus, in the field in which the semi-conductor substrate 3 was chosen, the bridge formation layer 4 is formed on 1st resist pattern 1a, and it can avoid forming a bridge formation layer in the 1st resist pattern in other fields, as shown in drawing 7 (f). Thereby, the detailed hole or detailed tooth space of a different dimension on the same semi-conductor substrate can be formed.

[0051] As mentioned above, although the formation approach which forms a detailed separation resist pattern upwards at the semi-conductor substrate 3 was explained to the detail, the detailed separation resist pattern of this invention may not be restricted on the semi-conductor substrate 3, may be formed on insulating layers, such as silicon oxide, according to the manufacture process of a semiconductor device, and may be formed on conductive layers, such as polish recon film. Thus, formation of the detailed separation resist pattern of this invention is not restrained by the substrate film, if it is on the base material which can form a resist pattern, in which case, will be applicable and will be formed on a base material as occasion demands. Suppose that these are named generically and a semi-conductor base material is called.

[0052] Moreover, in this invention, semi-conductor base materials, such as a semi-conductor substrate of a substrate or various thin films, are etched by using as a mask the detailed separation resist pattern formed as mentioned above, a detailed tooth space or a detailed hole is formed in a semi-conductor base material, and a semiconductor device is manufactured. Moreover, it is effective in surface roughening of the base material pattern side-attachment-wall front face after etching being carried out by setting up appropriately the ingredient of the 2nd resist and an ingredient presentation, or MB temperature, and etching a semi-conductor base material by using as a mask the detailed separation resist pattern which formed the bridge formation layer on the 1st resist, and was obtained.

[0053] Gestalt 2. drawing 8 of operation is a process-flow Fig. for explaining the detailed separation resist pattern formation approach of the gestalt 2 implementation this invention. With reference to drawing 1 and drawing 8, the formation approach of the detailed separation resist pattern of the gestalt 2 this operation and the manufacture approach of the semiconductor device using this are explained.

[0054] First, as shown in drawing 8 (a), the 1st resist 11 which contains some acid inside is applied to

the semi-conductor substrate 3. The 1st resist 11 carries out projection exposure using the mask containing a pattern like drawing 1 using g line or i line of Hg lamp, after prebaking (it is heat treatment for about 1 minute at 70-100 degrees C) (it is omitting in drawing 8 ). Drawing 8 (b) shows 1st resist pattern 11a formed in this way. As an ingredient of the 1st resist 11 used here, what was explained with the gestalt 1 of operation is used effectively. The detailed explanation is omitted in order to avoid duplication. Moreover, specifically as an acid included in the 1st resist 11, the low-molecular acid of a carboxylic-acid system etc. is suitable.

[0055] Then, after heat-treating by PEB (10-130 degrees C) and raising the resolution of a resist if needed, negatives are developed using about 2.0% dilution water bath liquid of TMAH (tetramethylammonium hydroxide). Then, postdeveloping BEKU may be performed if needed. Since this heat treatment influences a next mixing reaction, it is necessary to set it as suitable temperature. The above is the same as that of formation of the resist pattern by the conventional resist process as a process, if the point of using the resist 11 containing an acid is set aside.

[0056] Next, as shown in drawing 8 (c) after the pattern formation of drawing 8 (b), the cross-linking ingredient which constructs a bridge by existence of an acid on the semi-conductor substrate 3 is used as a principal component, and the 2nd resist 12 melted by the solvent which does not dissolve the 1st resist 11 is applied. The ingredient of the 2nd resist 12 used here and its solvent can apply what was stated with the gestalt 1 of operation, and the same thing, and are effective. The detailed explanation is omitted in order to exclude duplication. . Next, this is prebaked after spreading of the 2nd resist 12 if needed. Since this heat treatment influences a next mixing reaction, it is desirable to set it as suitable temperature.

[0057] Next, the semi-conductor substrate 3 is heat-treated (60-130 degrees C), and crosslinking reaction is made to cause near the interface with 1st resist pattern 11a of the 2nd resist 12 by supply of the acid from some acid contained in 1st resist pattern 11a, as shown in drawing 8 (d). The bridge formation layer 14 which caused crosslinking reaction by this so that 1st resist pattern 11a might be covered is formed into the 2nd resist 12.

[0058] Next, as shown in drawing 8 (f), development exfoliation of the part over which the 2nd resist 12 is not constructing a bridge using developers, such as water or TMAH, is carried out. It becomes possible to obtain the resist pattern which reduced the hole bore of a hole pattern, or the separation width of face of the Rhine pattern, or the resist pattern to which the area of an isolated remnants pattern was expanded by the above processing.

[0059] As mentioned above, the 1st resist 11 in the gestalt 2 of this operation does not have the need of generating an acid by exposure, and it diffuses that acid by heat treatment, and he is trying to make it to be adjusted so that an acid may be included in resist film 11 the very thing, and construct a bridge. As an acid included in this 1st resist 11, although the low-molecular acid of a carboxylic-acid system etc. is suitable, if mixing in a resist solution is possible, especially limitation will not be carried out.

[0060] Moreover, it is the same as that of the gestalt 1 of the operation described previously to form this detailed separation resist pattern on various kinds of semi-conductor base materials, and to form [ hole / a detailed separation tooth space or / detailed ] it on a semi-conductor base material, using this as a mask.

[0061] Gestalt 3. drawing 9 of operation is a process-flow Fig. for explaining the formation approach of the detailed separation resist pattern of the gestalt 3 implementation this invention. With reference to drawing 1 and drawing 9 , the formation approach of the detailed separation resist pattern of the gestalt 3 this operation and the manufacture approach of the semiconductor device using this are explained.

[0062] First, as shown in drawing 9 (a), the 1st resist 21 is applied to the semi-conductor substrate 3. After prebaking to the 1st resist 21 (it is heat treatment for about 1 minute at 70 to 100 degree C), projection exposure is carried out using the mask containing a pattern like drawing 1 R> 1 using g line or i line of Hg lamp, corresponding to the sensitization wavelength of the 1st resist 21 (illustration is omitted in drawing 9 ). As an ingredient of the 1st resist 21 used here, what was explained with the gestalt 1 of operation is used effectively. The detailed explanation is omitted in order to avoid duplication.

[0063] Next, after it heat-treats by PEB (10-130 degrees C) and a resist carries out improvement in resolution if needed, negatives are developed using about 2.0% dilution water solution of TMAH (tetramethylammonium hydroxide). Drawing 9 (b) shows pattern 21a of the 1st resist formed in this way. Then, postdeveloping BEKU may be performed if needed. Since this heat treatment influences a next mixing reaction, it is necessary to set it as suitable temperature. The above is the same as that of formation of the resist pattern by the conventional resist process as a process.

[0064] As shown after the pattern formation of drawing 9 (b), next in drawing 9 (c), immersion processing of the semi-conductor substrate 3 is carried out with an acidic solution. The art is good in the method of the usual paddle development. Moreover, you may carry out by the vapor rise (blasting) of an acidic solution. Moreover, surface treatment may be carried out by the sour gas. Any of an organic acid and an inorganic acid are sufficient as the acidic solution or sour gas in this case. Specifically, a low-concentration acetic acid is mentioned as a suitable example. In this process, an acid sinks in near the interface of 1st resist pattern 21a, and the film containing an acid is formed. Then, a rinse is carried out using pure water if needed.

[0065] Then, as shown in drawing 9 (e), the cross-linking ingredient which constructs a bridge by existence of an acid on the 1st resist pattern 21 is used as a principal component, and the 2nd resist 22 melted by the solvent which does not dissolve the 1st resist 21 is applied. What has the ingredient of the 2nd resist 22 used here and its solvent be [ the same as that of what was stated with the gestalt 1 of operation ] it is used effectively. In order to avoid duplication, the detailed explanation is omitted. Next, the 2nd resist 22 is prebaked after spreading of the 2nd resist 22 if needed. Since this heat treatment influences a next mixing reaction, it is set as suitable temperature.

[0066] Next, the semi-conductor substrate 3 is heat-treated (60-130 degrees C), bridge formation BEKU is performed, and crosslinking reaction is made to cause by supply of the acid from the 1st resist pattern 21a near the interface with 1st resist pattern 21a of the 2nd resist 22, as shown in drawing 9 (f). The bridge formation layer 4 which caused crosslinking reaction by this so that 1st resist pattern 21a might be covered is formed into the 2nd resist 22.

[0067] Next, as shown in drawing 9 (g), development exfoliation of the part over which the 2nd resist 22 is not constructing a bridge using developers, such as water or TMAH, is carried out. It becomes possible to obtain the resist pattern which reduced the hole bore of a hole pattern, or the separation width of face of the Rhine pattern by the above processing.

[0068] As mentioned above, before not needing the process which generates an acid for the 1st resist but forming the 2nd resist 22 on 1st resist pattern 21a by exposure processing, surface treatment by the acid liquid or the sour gas is performed, and an acid is diffused by heat treatment at a next process, and it is made to construct a bridge according to the gestalt 3 of this operation.

[0069] Moreover, it is the same as that of the gestalten 1 and 2 of the operation described previously to form the detailed separation resist pattern which carried out in this way and was formed on various kinds of semi-conductor substrates, to form a detailed separation tooth space or a detailed detailed hole etc. on a semi-conductor substrate by making this into a mask, and to manufacture a semiconductor device.

[0070]

[Example] Next, the example relevant to the gestalten 1-3 of each aforementioned operation is explained. Since one example may be related to the gestalt of one or more operations, it explains collectively. First, the examples 1-5 about the 1st resist ingredient are explained.

As the example 1. 1st resist, it consisted of novolak resin and naphthoquinonediazide and the resist pattern was formed using i line resist using ethyl lactate and propylene glycol monoethyl acetate as a solvent. First, said resist was dropped on Si wafer, after carrying out rotation spreading, it prebaked in 85 degrees C / 70 seconds, the solvent in a resist was evaporated, and the 1st resist was formed by about 1.0 micrometers of thickness. Next, the 1st resist was exposed as an exposure mask using the mask as shown in drawing 1, using i line contraction projection aligner as an aligner. Next, PEB processing was performed in 120 degrees C / 70 seconds, then negatives were developed using the alkali developer (the TOKYO OHKA KOGYO CO., LTD. make, NMD3), and the resist pattern with separation size as shown in drawing 10 was obtained.

[0071] As the example 2. 1st resist, it consisted of novolak resin and naphthoquinonediazide and the resist pattern was formed using i line resist using 2-heptanone as a solvent. First, said resist was formed so that it might become about 0.8 micrometers of thickness by dropping and rotation spreading on Si wafer. Next, it prebaked in 85 degrees C / 70 seconds, and the solvent in a resist was dried. Then, it exposed using the mask as shown in drawing 1 using i line contraction projection aligner. Next, PEB processing was performed in 120 degrees C / 70 seconds, then negatives were developed using the alkali developer (Tokyo adaptation shrine make, NMD3), and the resist pattern with separation size as shown in drawing 10 was obtained.

[0072] As the example 3. 1st resist, it consisted of novolak resin and naphthoquinonediazide and the resist pattern was formed using i line resist using the mixed solvent of ethyl lactate and butyl acetate as a solvent. First, said resist was formed so that it might become about 1.0 micrometers of thickness by dropping and rotation spreading on Si wafer. Next, it prebaked in 100 degrees C / 90 seconds, and the solvent in a resist was dried. Then, it exposed using the mask as shown in drawing 1 R> 1 using SUTEBBA by NIKON CORP. Next, PEB processing was performed in 110 degrees C / 60 seconds, then negatives were developed using the alkali developer (Tokyo adaptation shrine make, NMD3), and the resist pattern as shown in drawing 10 was obtained.

[0073] as the example 4. 1st resist -- Tokyo -- adaptation -- the resist pattern was formed using the shrine chemistry magnification mold excimer resist. First, said resist was formed so that it might become about 0.8 micrometers of thickness by dropping and rotation spreading on Si wafer. Next, it prebaked in 90 degrees C / 90 seconds, and the solvent in a resist was dried. Then, it exposed using the mask as shown in drawing 1 using the KrF excimer contraction projection aligner. Next, PEB processing was performed in 100 degrees C / 90 seconds, then negatives were developed using the alkali developer (Tokyo adaptation shrine make, NMD-W), and the resist pattern as shown in drawing 11 was obtained.

[0074] As the example 5. 1st resist, the resist pattern was formed using the chemistry magnification mold resist (2773 MELKER, J.Vac.Sci.Technol., B11 (6) 1993) by Ryoden Kasei CO., LTD. which consists of t-Boc-ized polyhydroxy styrene and an acid generator. First, said resist was formed so that it might become about 0.52 micrometers of thickness by dropping and rotation spreading on Si wafer. Next, \*\* -KU was performed in 120 degrees C / 180 seconds, and the solvent in a resist was dried. then, this resist top -- as the antistatic film -- the Showa Denko K.K. make -- after carrying out rotation spreading of S pay sir ESP-100 similarly, \*\* -KU was performed in 80 degrees C / 120 seconds. Next, it drew by 17.4microC/cm2 using EB drawing equipment. Next, after performing PEB in 80 degrees C / 120 seconds, pure water was used, and the resist pattern was continuously exfoliation and developed using the TMAH alkali developer (Tokyo adaptation shrine NMD-W) in the antistatic film. Consequently, about 0.2-micrometer EB resist pattern as shown in drawing 12 was obtained.

[0075] Next, the examples 6-13 about the 2nd resist ingredient are explained.

example 6. -- as the 2nd resist ingredient -- 1L measuring flask -- using -- 20wt% water-solution: of the polyvinyl-acetal resin S leks KW3 and KW1 by Sekisui Chemical Co., Ltd. -- pure-water:400g was added to 100g, respectively, stirring mixing was carried out at the room temperature for 6 hours, and the 5wt% water solution of polyvinyl-acetal resin KW3 and KW1 was obtained, respectively.

[0076] example 7. -- as 2nd resist ingredient, it replaced with the polyvinyl-acetal resin of an example 6, and each 5wt% water solution was obtained like the example 6 using polyvinyl alcohol resin, oxazoline content water soluble resin (the NIPPON SHOKUBAI Co., Ltd. make, the EPO cross WS 500), and a styrene maleic anhydride copolymer (the product made from ARCOchemical, SMA 1000 and 1440H).

[0077] example 8. -- using 1L measuring flask as 2nd resist ingredient, stirring mixing of methoxy methylol melamine (product [ made from Mitsui SAINAMIDO ], Cymel 370):100g, pure-water:780g, and the IPA:40g was carried out at the room temperature for 6 hours, and the about 10 wt(s)% methylol melamine water solution was obtained.

[0078] example 9. -- using 1L measuring flask as 2nd resist ingredient, in methoxy (N-methoxymethyl) ethylene urea:100g, hydroxy (N-methoxymethyl) ethylene urea:100g, and N-methoxymethyl urea:100g, stirring mixing of pure-water:860g and the IPA:40g was carried out at the room temperature for 6 hours, and the about 10 wt(s)% ethylene urea water solution was obtained, respectively.

[0079] example 10. -- stirring mixing of KW3 water-solution:160g of the polyvinyl acetal obtained in the example 6 and methoxy methylol melamine water-solution:20g obtained in the example 8 and the pure-water:20g was carried out at the room temperature as 2nd resist ingredient for 6 hours, and water soluble resin and the mixed solution of a water-soluble cross linking agent were obtained.

[0080] example 11. -- as 2nd resist ingredient, in KW3 water-solution:160g of the polyvinyl acetal obtained in the example 6, methoxy (N-methoxymethyl) ethylene urea water-solution:20g obtained in the example 9, hydroxy (N-methoxymethyl) ethylene urea:20g, and N-methoxymethyl urea:20g, stirring mixing of the pure-water:20g was carried out at the room temperature for 6 hours, and water soluble resin and the mixed solution of a water-soluble cross linking agent were obtained, respectively.

[0081] example 12. -- each was mixed for KW3 water-solution:160g of the polyvinyl acetal obtained in the example 6, and 10g, 20g, 30g of the methoxy ethylene urea water solution obtained in the example 9, and pure-water:20g under the room temperature as 2nd resist ingredient for 6 hours. Consequently, the concentration of the methoxy ethylene urea which is a water-soluble cross linking agent to polyvinyl-acetal resin obtained three kinds of 2nd 27wt% resist water solution 20wt% about 1 lwt%.

[0082] As the example 13. 2nd resist, stirring mixing of the 5wt% water solution of polyvinyl alcohol resin was carried out under the room temperature by mixing 0g, 35.3g, and 72.2g for 6 hours among the water-soluble-resin solutions obtained in the example 7 to 100g of the 5wt(s)% polyvinyl-acetal resin water solution obtained in the example 6, and three kinds of mixed solutions with which the mixing ratios of polyvinyl-acetal resin and polyvinyl alcohol resin differ were obtained.

[0083] Next, the examples 14-22 of detailed resist pattern formation are explained.

On Si wafer with which the 1st resist pattern obtained in the example 14. example 3 was formed, after dropping and carrying out the spin coat of the 2nd resist ingredient obtained in the example 12, it prebaked in 85 degrees C / 70 seconds, and the 2nd resist film was formed. Next, mixing BEKU (MB) was performed in 120 degrees C / 90 seconds, and crosslinking reaction was advanced. Next, by developing negatives using pure water, carrying out development exfoliation of the layer non-constructing a bridge, and performing postbake in next 90 degrees C / 90 seconds, the 2nd resist bridge formation layer was formed on the 1st resist pattern, and as shown in drawing 13 , the 2nd resist pattern was formed. In drawing 13 , the mixing ratio of water soluble resin was changed by having made the diameter of a hole of the 2nd resist pattern into the length measurement location, and the resist pattern size after the bridge formation stratification was measured. This result is shown in the table of drawing 14 R> 4. In this case, by changing the amount of mixing of polyvinyl-acetal resin and polyvinyl alcohol resin shows that it is possible to control the thickness of the bridge formation layer formed on the 1st resist.

[0084] On Si wafer with which the 1st resist pattern obtained in the example 15. example 2 was formed, after the resin water solution of KW1 obtained in the example 6 was dropped as 2nd resist ingredient and carried out the spin coat, it prebaked in 85 degrees C / 70 seconds, and the 2nd resist film was formed. Next, complete exposure was performed to the wafer using i line aligner. Furthermore, mixing BEKU (MB) was performed in 150 degrees C / 90 seconds, and crosslinking reaction was advanced. Next, negatives were developed using pure water, development exfoliation of the layer non-constructing a bridge was carried out, and the 2nd resist bridge formation layer was formed on the hole pattern which is the 1st resist pattern like what was shown in drawing 13 by performing postbake in 110 degrees C / 90 seconds continuously. The resist pattern size after the bridge formation stratification was measured about the case where it does not consider as the case where complete exposure is carried out by making into a length measurement location the diameter of a hole of the 2nd resist pattern shown in drawing 13 . This result is shown in the table of drawing 15 15. When the 1st resist hole pattern size of 0.4 micrometers before forming a bridge formation layer performed complete exposure by this and about 0.14 micrometers and complete exposure were not performed, it was reducing by about 0.11 micrometers. In this case, by performing complete exposure before MB \*-KU, compared with the case where it does not carry out, crosslinking reaction advanced more and the bridge formation layer was thickly formed in the 1st resist front face.

[0085] On Si wafer with which the 1st resist pattern obtained in the example 16. example 2 was formed,

the mixed solution of the polyvinyl-acetal resin obtained in the example 11 and an ethylene urea was used as the 2nd resist. After dropping and carrying out the spin coat of the 2nd resist ingredient, it prebaked in 85 degrees C / 70 seconds, and the 2nd resist film was formed. Next, for 105 degrees C / 90 seconds, for 115 degrees C / 90 seconds, mixing BEKU (MB) was performed on three kinds of conditions for 125 degrees C / 90 seconds, and crosslinking reaction was performed. Next, negatives were developed using pure water and development exfoliation of the non-cross linking agent was carried out, and by performing postbake in 90 degrees C / 90 seconds continuously, as shown in drawing 16 , the 2nd resist bridge formation layer was formed on the 1st resist pattern. The temperature of mixing BEKU (MB) was changed by having made into the length measurement location the tooth space in the diameter of a hole, the Rhine pattern, and isolated remnants pattern of the 2nd resist pattern shown in drawing 16 , and the resist pattern size after the bridge formation stratification was measured. This result is shown in the table of drawing 17 . Consequently, with the resist pattern after the bridge formation stratification, the size of the tooth space in the bore of a hole pattern, and the Rhine pattern and an isolated remnants pattern of 0.4-micrometer size formed in the example 2 is reduced, as shown in drawing 17 , and the amount of contraction is increasing while MB temperature becomes high. From this, the temperature control of MB shows that control of crosslinking reaction is possible with a sufficient precision.

[0086] On Si wafer with which the 1st resist pattern obtained in the example 17. example 3 was formed, the mixed solution from which the concentration of an ethylene urea differs with the polyvinyl-acetal water solution obtained in the example 6, the polyvinyl-acetal resin obtained in the example 12 and an ethylene urea mixed water solution, and polyvinyl alcohol resin and an ethylene urea mixed water solution was used as the 2nd resist. After dropping and carrying out the spin coat of the 2nd resist ingredient, it prebaked in 85 degrees C / 70 seconds, and the 2nd resist film was formed. Next, mixing BEKU (MB) was performed in 65 degrees C / 70 +100 degrees C / per second, and 90 seconds, and crosslinking reaction was performed. Next, negatives were developed using pure water, development exfoliation of the layer non-constructing a bridge was carried out, and the 2nd resist bridge formation layer was formed on the 1st resist pattern like what was shown in drawing 13 by performing postbake in 90 degrees C / 90 seconds continuously. The amount of mixing of a water-soluble cross linking agent was changed by having made into the length measurement location the diameter of a hole of the 2nd resist pattern shown in drawing 13 , and the resist pattern size after the bridge formation stratification was measured. This result is shown in the table of drawing 18 . Consequently, the bore of the hole pattern of about 0.4-micrometer size formed in the example 3 is reduced as shown in drawing 18 , and the amount of contraction becomes so large that the amount of mixing of a water-soluble cross linking agent increases. From this, by adjusting the mixing ratio of a water-soluble ingredient shows that control of crosslinking reaction is possible with a sufficient precision. Moreover, but by [ with the same amount of cross linking agents ] changing the class of water soluble resin shows that it is possible to control the amount of contraction.

[0087] On Si wafer with which the 1st resist pattern obtained in the example 18. example 3 was formed, the polyvinyl-acetal water solution obtained in the example 6, the polyvinyl-acetal resin water solution obtained in the example 11, and the mixed solution of the N-methoxymethyl-methoxy ethylene urea mixed water solution which is a water-soluble cross linking agent, a hydroxy (N-methoxymethyl) ethylene urea, and N-methoxymethyl urea were used as the 2nd resist. After dropping and carrying out the spin coat of the 2nd resist ingredient, it prebaked in 85 degrees C / 70 seconds, and the 2nd resist film was formed. Next, mixing BEKU (MB) was performed in 65 degrees C / 70 +100 degrees C / per second, and 90 seconds, and crosslinking reaction was performed. Next, negatives were developed using pure water, development exfoliation of the layer non-constructing a bridge was carried out, and the 2nd resist bridge formation layer was formed on the 1st resist pattern like what was shown in drawing 13 by performing postbake in 90 degrees C / 90 seconds continuously. The water-soluble cross linking agent was changed by having made into the length measurement location the diameter of a hole of the 2nd resist pattern shown in drawing 13 , and the resist pattern size after the bridge formation stratification was measured. This result is shown in the table of drawing 19 . Consequently, the bore of the hole

pattern of about 0.4-micrometer size formed in the example 3 is reduced as shown in drawing 19 , and as for the amount of contraction, a difference is accepted by the difference in a water-soluble cross linking agent. From this, the difference in the class of water-soluble ingredient to mix shows that control of crosslinking reaction is possible.

[0088] On Si wafer with which the 1st resist pattern obtained in the example 19. example 4 was formed, the polyvinyl-acetal water solution obtained in the example 6, and the polyvinyl-acetal resin water solution obtained in the example 11 and the methoxy ethylene urea mixed water solution which is a water-soluble cross linking agent were used as the 2nd resist. After dropping and carrying out the spin coat of the 2nd resist ingredient, it prebaked in 85 degrees C / 70 seconds, and the 2nd resist film was formed. Next, mixing BEKU for 90 seconds (MB) was performed at predetermined temperature, and crosslinking reaction was performed. Next, negatives were developed using pure water, development exfoliation of the layer non-constructing a bridge was carried out, and the 2nd resist bridge formation layer was formed on the 1st resist pattern like what was shown in drawing 13 by performing postbake in 90 degrees C / 90 seconds continuously. The amount of a water-soluble cross linking agent and reaction temperature were changed by having made into the length measurement location the diameter of a hole of the 2nd resist pattern shown in drawing 13 , and the resist pattern size after the bridge formation stratification was measured. This result is shown in the table of drawing 20 . Consequently, the resist pattern size of about 0.3 micrometers formed in the example 4 is reduced as shown in drawing 20 , and a difference is accepted with the amount of water-soluble cross linking agents, and reaction temperature. Also when the chemistry magnification mold resist which generates an acid by optical exposure is used from this, it turns out that control of the resist pattern size by crosslinking reaction is possible.

[0089] On Si wafer with which the 1st resist pattern obtained in the example 20. example 5 was formed, the polyvinyl-acetal water solution obtained in the example 6, and the polyvinyl-acetal resin water solution obtained in the example 11 and the methoxy ethylene urea mixed water solution which is a water-soluble cross linking agent were used as the 2nd resist. After dropping and carrying out the spin coat of the 2nd resist ingredient, it prebaked in 85 degrees C / 70 seconds, and the 2nd resist film was formed. Next, mixing BEKU (MB) was performed in 105 or 115 degrees C / 90 seconds, and crosslinking reaction was performed. Next, negatives were developed using pure water and development exfoliation of the layer non-constructing a bridge was carried out, and by performing postbake in 90 degrees C / 90 seconds continuously, as shown in drawing 13 , the 2nd resist bridge formation layer was formed on the 1st resist pattern. The amount of a water-soluble cross linking agent and reaction temperature were changed by having made into the length measurement location the diameter of a hole of the 2nd resist pattern shown in drawing 13 , and the resist pattern size after the bridge formation stratification was measured. This result is shown in the table of drawing 21 . Consequently, the size of the resist pattern of about 0.2-micrometer size formed in the example 5 is reduced as shown in drawing 21  $R > 1$ , and as for the amount of contraction, a difference is accepted by the difference in a water-soluble ingredient, and the difference in MB temperature. Also when EB resist of the chemistry magnification mold which consists of t-Boc-ized polyhydroxy styrene and an acid generator is used from this, it turns out that control of the resist pattern size by crosslinking reaction is possible.

[0090] On the 1st resist pattern obtained in the example 21. example 2, the electron ray was irradiated alternatively. The exposure of an electron ray irradiated 50microC/cm<sup>2</sup>. Next, the polyvinyl-acetal resin water solution obtained in the example 11 and the methoxy ethylene urea mixed water solution which is a water-soluble cross linking agent were applied as the 2nd resist on the 1st resist pattern which irradiated the electron ray. Spreading trickled the 2nd resist ingredient, and performed the spin coat, then prebaked in 85 degrees C / 70 seconds, and formed the 2nd resist film. Furthermore, mixing BEKU (MB) was performed in 120 degrees C / 90 seconds, and crosslinking reaction was performed. The 2nd resist bridge formation film was alternatively formed on the 1st resist pattern like what was shown in drawing 13 by developing negatives by using pure water finally, carrying out development exfoliation of the layer non-constructing a bridge, and performing postbake in next 110 degrees C / 70 seconds. The resist pattern size after the bridge formation stratification was measured about the exposure part of an electron ray, and the non-irradiated part by making into a length measurement location the diameter of a



hole of the 2nd resist pattern shown in drawing 13 . This result is shown in the table of drawing 22 . Consequently, in the part which did not irradiate an electron ray, about 0.4-micrometer resist pattern formed in the example 2 was reduced, as shown in drawing 22 , about the part which irradiated the electron ray alternatively, crosslinking reaction did not occur and contraction of hole size was not seen. By the pattern of the part irradiated by irradiating an electron ray alternatively after forming a resist pattern from this, since a reaction does not arise, it turns out that size control of an alternative resist pattern is possible.

[0091] The 1st resist pattern obtained in the example 22. example 2 was formed on Si wafer with which the oxide film was formed, and the 1st resist pattern as shown in drawing 23 was formed. Next, after dropping and carrying out the spin coat of the 2nd resist ingredient obtained in the example 12 and prebaking in 85 degrees C / 70 seconds, the 2nd resist bridge formation layer was formed on the 1st resist pattern by carrying out development exfoliation of the layer non-constructing a bridge with pure water, performing mixing BEKU in 105 degrees C / 90 seconds, and performing postbake in 90 degrees C / 90 seconds continuously. Furthermore, the substrate oxide film was etched using the etching system, and the pattern configuration after etching was observed. Moreover, it etched similarly about the wafer in which the 1st resist pattern shown in drawing 23 which does not process this invention as an example of a comparison was formed. Consequently, while separation width of face was reduced as shown in drawing 24 (b) and (c) when this invention was applied as compared with drawing 24 (a) when not applying this invention, the oxide-film pattern with which surface roughening of the side attachment wall was carried out was obtained. Moreover, it turns out that extent of surface roughening is controllable by the amount of mixing of a cross linking agent.

[0092]

[Effect of the Invention] As mentioned above, as explained to the detail, according to this invention, the charge of detailed separation resist pattern formation material which makes pattern formation exceeding a wavelength limitation possible, and the detailed pattern formation approach using it are acquired in detailed-izing of the separation pattern of a resist, and a hole pattern. Thereby, the diameter of a hole of a Hall system resist pattern can be reduced conventionally, and the separation width of face of a SU \*\*-SU system resist pattern can be reduced conventionally. moreover, the tooth space by which detailed separation was carried out on the semi-conductor base material, using as a mask the detailed separation resist pattern which carried out in this way and was formed -- or hole formation can be carried out. Moreover, the semiconductor device which has the tooth space or hole by which detailed separation was carried out by such manufacture approach can be obtained.

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[Translation done.]



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**CLAIMS**

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**[Claim(s)]**

[Claim 1] The detailed pattern formation ingredient which uses one kind of water soluble resin, or two kinds or more of said water soluble resin of mixture, or the copolymerization object by two or more kinds of said water soluble resin as a principal component, and is characterized by producing crosslinking reaction by existence of an acid.

[Claim 2] The detailed pattern formation ingredient according to claim 1 characterized by using one kind in polyacrylic acid, a polyvinyl acetal, a polyvinyl pyrrolidone, polyvinyl alcohol, polyethyleneimine, polyethylene oxide, a styrene maleic anhydride copolymer, a polyvinyl amine, the poly allylamine, oxazoline radical content water soluble resin, water-soluble melamine resin, a water-soluble urea-resin, an alkyd resin, and a sulfonamide, or these two kinds or more of mixture, or these salts as a principal component as said water soluble resin.

[Claim 3] The detailed pattern formation ingredient which uses one kind of a water-soluble cross linking agent, or two kinds or more of said water-soluble cross linking agent of mixture as a principal component, and is characterized by producing crosslinking reaction by existence of an acid.

[Claim 4] The detailed pattern formation ingredient according to claim 3 characterized by using one kind or these two kinds or more of mixture of a melamine derivative, a urea derivative, benzoguanamine, and the glycoluryl as a principal component as said water-soluble cross linking agent.

[Claim 5] The detailed pattern formation ingredient according to claim 4 characterized by using one kind or such mixture of a melamine and the alkoxy methylene melamines as a principal component as said melamine derivative.

[Claim 6] The detailed pattern formation ingredient according to claim 4 characterized by using one kind or these two kinds or more of mixture of a urea, alkoxy methyleneurea, N-alkoxy methyleneurea, an ethylene urea, and an ethylene urea carboxylic acid as a principal component as said urea derivative.

[Claim 7] The detailed pattern formation ingredient which uses one kind of water soluble resin or two kinds or more, one kind of a water-soluble cross linking agent, or two kinds or more of mixture as a principal component, and is characterized by producing crosslinking reaction by existence of an acid.

[Claim 8] The detailed pattern formation ingredient according to claim 7 characterized by using either of the mixture of a melamine derivative, a urea derivative or a melamine derivative, and a urea derivative as said water-soluble cross linking agent, using either of the mixture of a polyvinyl acetal, polyvinyl alcohol or polyvinyl alcohol, and a polyvinyl acetal as said water soluble resin.

[Claim 9] The detailed pattern formation ingredient according to claim 1 to 8 characterized by including a plasticizer as an additive.

[Claim 10] The detailed pattern formation ingredient according to claim 1 to 8 characterized by including a surfactant as an additive.

[Claim 11] The process which forms the 1st resist pattern which may generate an acid on a semiconductor base material by the 1st resist, The process which forms the 2nd resist which causes crosslinking reaction by existence of an acid on said 1st resist pattern, Down stream processing which forms the bridge formation film in the part which touches said 1st resist pattern of said 2nd resist by

supply of the acid from said 1st resist pattern, The manufacture approach of the semiconductor device characterized by including the process which exfoliates the part of said 2nd resist non-constructing a bridge, and forms the 2nd resist pattern, and the process which etches said semi-conductor base material by using this 2nd resist pattern as a mask.

[Claim 12] The manufacture approach of the semiconductor device according to claim 11 characterized by forming said 1st resist pattern by the resist which generates an acid by heat-treatment.

[Claim 13] The manufacture approach of the semiconductor device according to claim 11 characterized by forming said 1st resist pattern by the resist which generates an acid by exposure.

[Claim 14] The manufacture approach of the semiconductor device according to claim 11 characterized by forming said 1st resist pattern by the resist containing an acid.

[Claim 15] The manufacture approach of the semiconductor device according to claim 11 characterized by forming said 1st resist pattern by the resist which performed surface preparation by the acid liquid or acid gases.

[Claim 16] The manufacture approach of the semiconductor device according to claim 11 to 15 characterized by using the resist which uses novolak resin and mixture of a naphthoquinonediazide system sensitization agent as a principal component as said 1st resist.

[Claim 17] The manufacture approach of the semiconductor device according to claim 11 to 15 characterized by using the chemistry magnification mold resist which has the device in which an acid is generated, as said 1st resist.

[Claim 18] The manufacture approach of the semiconductor device according to claim 11 characterized by using said detailed pattern formation ingredient according to claim 1 to 10 as said 2nd resist.

[Claim 19] The manufacture approach of the semiconductor device according to claim 11 characterized by controlling reacting weight with said 1st resist by adjusting the amount of mixing of said water soluble resin and said water-soluble cross linking agent, using said detailed pattern formation ingredient according to claim 7 as said 2nd resist.

[Claim 20] The manufacture approach of the semiconductor device according to claim 11 characterized by controlling reacting weight with said 1st resist by adjusting the degree of acetalization of said polyvinyl acetal, using said detailed pattern formation ingredient according to claim 8 as the 2nd resist.

[Claim 21] The manufacture approach of the semiconductor device according to claim 11 to 20 characterized by using water or a water-soluble mixed solvent as a solvent of said 2nd resist.

[Claim 22] The manufacture approach of a semiconductor device given in claim 11 characterized by forming said bridge formation film in contact with the front face of said 1st resist pattern by heat-treating said 1st resist pattern and said 2nd resist formed on said 1st resist pattern thru/or any 1 term of 21.

[Claim 23] By exposing a predetermined field from on said 2nd resist formed on said 1st resist pattern and said 1st resist pattern, there is nothing to claim 11 characterized by forming said bridge formation film in said predetermined field of said 1st resist pattern, and it is the manufacture approach of a semiconductor device given in either of 21.

[Claim 24] There is nothing to claim 11 which carries out electron beam irradiation of except for the predetermined field of said 1st resist pattern, and is characterized by forming said 2nd resist on this 1st resist pattern by which electron beam irradiation was carried out, and forming said bridge formation film in said predetermined field of said 1st resist pattern, and it is the manufacture approach of a semiconductor device given in either of 21.

[Claim 25] The semiconductor device characterized by manufacturing by the manufacture approach of the semiconductor device indicated to said claim 11 thru/or either of 24.

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[Translation done.]

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**DESCRIPTION OF DRAWINGS**

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[Brief Description of the Drawings]

[Drawing 1] Drawing of the mask pattern for explaining the resist pattern formation approach of the gestalt 1 implementation this invention.

[Drawing 2] The process flow Fig. for explaining the resist pattern formation approach of the gestalt 1 implementation this invention.

[Drawing 3] The process flow Fig. for explaining the resist pattern formation approach of the gestalt 1 implementation this invention.

[Drawing 4] The process flow Fig. for explaining the resist pattern formation approach of the gestalt 1 implementation this invention.

[Drawing 5] The process flow Fig. for explaining the resist pattern formation approach of the gestalt 1 implementation this invention.

[Drawing 6] The process flow Fig. for explaining the resist pattern formation approach of the gestalt 1 implementation this invention.

[Drawing 7] The process flow Fig. for explaining the resist pattern formation approach of the gestalt 1 implementation this invention.

[Drawing 8] The process flow Fig. for explaining the resist pattern formation approach of the gestalt 2 implementation this invention.

[Drawing 9] The process flow Fig. for explaining the resist pattern formation approach of the gestalt 3 implementation this invention.

[Drawing 10] The 1st resist pattern in the examples 1, 2, and 3 of this invention.

[Drawing 11] The 1st resist pattern in the example 4 of this invention.

[Drawing 12] The 1st resist pattern in the example 5 of this invention.

[Drawing 13] The 2nd resist pattern in the example 14 of this invention.

[Drawing 14] Drawing showing the mixing ratio of the water soluble resin in the example 14 of this invention, and the resist pattern size after the bridge formation stratification.

[Drawing 15] Drawing showing the resist pattern size after the existence of the exposure in the example 15 of this invention, and the bridge formation stratification.

[Drawing 16] The 2nd resist pattern in the example 16 of this invention

[Drawing 17] Drawing showing the mixing baking temperature in the example 16 of this invention, and the resist pattern size after the bridge formation stratification.

[Drawing 18] Drawing showing the mixing ratio of the water-soluble ingredient in the example 17 of this invention, and the resist pattern size after the bridge formation stratification.

[Drawing 19] Drawing showing the resist pattern size after the class of water-soluble ingredient in the example 18 of this invention, and the bridge formation stratification.

[Drawing 20] Drawing showing the amount of the water-soluble ingredient in the example 19 of this invention, and mixing baking temperature and the resist pattern size after the bridge formation stratification.

[Drawing 21] Drawing showing the resist pattern size after the class of water-soluble ingredient in the

example 20 of this invention, and the bridge formation stratification.

[Drawing 22] Drawing showing the resist pattern size after the existence of the electron beam irradiation in the example 21 of this invention, and the bridge formation stratification.

[Drawing 23] Drawing showing the 2nd resist pattern in the example 22 of this invention.

[Drawing 24] Drawing showing the pattern configuration after etching of the substrate oxide film in the example 22 of this invention.

[Description of Notations]

1, 11, 21 The 1st resist 1a, 2a, 3a The 1st resist pattern 2, 12, 22 The 2nd resist 2a, 12a, 22a The 2nd resist pattern 3 Semi-conductor substrate (semi-conductor base material) 4, 14, 24 Bridge formation layer.

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[Translation done.]

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CORRECTION OR AMENDMENT

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 [Title of the Invention] It is a semiconductor device to a detailed pattern formation ingredient and the manufacture approach list of the semiconductor device using this.  
 [Claim(s)]  
 [Claim 1] The detailed pattern formation ingredient which uses one kind of water soluble resin, or two kinds or more of said water soluble resin of mixture, or the copolymerization object by two or more

kinds of said water soluble resin as a principal component, and is characterized by producing crosslinking reaction by existence of an acid.

[Claim 2] The detailed pattern formation ingredient which uses one kind of a water-soluble cross linking agent, or two kinds or more of said water-soluble cross linking agent of mixture as a principal component, and is characterized by producing crosslinking reaction by existence of an acid.

[Claim 3] The detailed pattern formation ingredient which uses one kind of water soluble resin or two kinds or more, one kind of a water-soluble cross linking agent, or two kinds or more of mixture as a principal component, and is characterized by producing crosslinking reaction by existence of an acid.

[Claim 4] The detailed pattern formation ingredient according to claim 1 to 3 characterized by including a surfactant as an additive.

[Claim 5] The manufacture approach of a semiconductor device characterized by providing the following The process which forms the 1st resist pattern which may generate an acid on a semiconductor base material by the 1st resist The process which forms the 2nd resist which causes crosslinking reaction by existence of an acid on said 1st resist pattern Down stream processing which forms the bridge formation film in the part which touches said 1st resist pattern of said 2nd resist by supply of the acid from said 1st resist pattern The process which exfoliates the part of said 2nd resist non-constructing a bridge, and forms the 2nd resist pattern, and the process which etches said semiconductor base material by using this 2nd resist pattern as a mask

[Claim 6] The manufacture approach of the semiconductor device according to claim 5 characterized by using said detailed pattern formation ingredient according to claim 1 to 4 as said 2nd resist.

[Claim 7] The manufacture approach of the semiconductor device according to claim 5 characterized by controlling reacting weight with said 1st resist by adjusting the amount of mixing of said water soluble resin and said water-soluble cross linking agent, using said detailed pattern formation ingredient according to claim 3 as said 2nd resist.

[Claim 8] The manufacture approach of the semiconductor device according to claim 5 characterized by controlling reacting weight with said 1st resist by adjusting the degree of acetalization of said polyvinyl acetal as the 2nd resist using said detailed pattern formation ingredient according to claim 3 which used the polyvinyl acetal as water soluble resin.

[Claim 9] The manufacture approach of the semiconductor device according to claim 5 to 8 characterized by forming said bridge formation film in contact with the front face of said 1st resist pattern by heat-treating said 1st resist pattern and said 2nd resist formed on said 1st resist pattern.

[Claim 10] The manufacture approach of the semiconductor device according to claim 5 to 8 characterized by forming said bridge formation film in said predetermined field of said 1st resist pattern by exposing a predetermined field from on said 2nd resist formed on said 1st resist pattern and said 1st resist pattern.

[Claim 11] The manufacture approach of the semiconductor device according to claim 5 to 8 which carries out electron beam irradiation of except for the predetermined field of said 1st resist pattern, and is characterized by forming said 2nd resist on this 1st resist pattern by which electron beam irradiation was carried out, and forming said bridge formation film in said predetermined field of said 1st resist pattern.

[Claim 12] The semiconductor device characterized by manufacturing by the manufacture approach of the semiconductor device indicated to said claim 5 thru/or either of 11.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] In a semi-conductor process, in case this invention forms a resist pattern, it relates to the formation approach of the ingredient for detailed separation resist patterns which reduces the separation size or hole opening size of a pattern, and the detailed separation pattern using it, the manufacture approach of the semiconductor device using this detailed separation resist pattern further, and the semiconductor device manufactured by this manufacture approach.

[0002]

[Description of the Prior Art] Wiring and separation width of face which are required of a manufacture

process are made detailed very much with high integration of a semiconductor device. Generally, formation of a detailed pattern forms a resist pattern with a photolithography technique, and is performed by the approach of etching the various thin films of a substrate by using the formed resist pattern as a mask after that.

[0003] Therefore, in formation of a detailed pattern, a photolithography technique becomes very important. The photolithography technique consists of resist spreading, mask alignment, exposure, and development, and the limitation has produced it from constraint of exposure wavelength in detailed-ization to detailed-izing. Furthermore, it was difficult to control the etching-proof nature of a resist by the conventional lithography process, and it was impossible to have controlled the shape of surface type, such as to carry out surface roughening of the pattern side-attachment-wall front face after etching, by control of etching-proof nature.

[0004]

[Problem(s) to be Solved by the Invention] As explained above, formation of the detailed resist pattern which exceeds the limitation of the wavelength with the photolithography technique by the conventional exposure was difficult. This invention offers the detailed separation resist pattern formation technique using this, and offers the technique to which control carries out surface roughening of the shape of pattern side-attachment-wall surface type after difficult etching with the conventional lithography technique in detailed-izing of a separation pattern and a hole pattern while it offers the water-soluble ingredient which does not dissolve the substrate resist which realizes detailed separation resist pattern formation which makes pattern formation exceeding a wavelength limitation possible. Furthermore the manufacture approach of the semiconductor device using that detailed separation resist pattern formation technique tends to be offered, and it is going to offer the semiconductor device manufactured by this manufacture approach.

[0005]

[Means for Solving the Problem] The detailed pattern formation ingredient concerning claim 1 of this invention uses one kind of water soluble resin, or two kinds or more of said water soluble resin of mixture, or the copolymerization object by two or more kinds of said water soluble resin as a principal component, and is characterized by producing crosslinking reaction by existence of an acid.

[0006] Moreover, the detailed pattern formation ingredient concerning claim 2 of this invention uses one kind of a water-soluble cross linking agent, or two kinds or more of said water-soluble cross linking agent of mixture as a principal component, and is characterized by producing crosslinking reaction by existence of an acid.

[0007] Moreover, the detailed pattern formation ingredient concerning claim 3 of this invention uses one kind of water soluble resin or two kinds or more, one kind of a water-soluble cross linking agent, or two kinds or more of mixture as a principal component, and is characterized by producing crosslinking reaction by existence of an acid.

[0008] Moreover, the detailed pattern formation ingredient concerning claim 4 of this invention is characterized by including a surfactant as an additive.

[0009] Next, this invention is characterized by providing the following in the manufacture approach of the semiconductor device concerning claim 5. The process which forms the 1st resist pattern which may generate an acid on a semi-conductor base material by the 1st resist The process which forms the 2nd resist which causes crosslinking reaction by existence of an acid on said 1st resist pattern Down stream processing which forms the bridge formation film in the part which touches said 1st resist pattern of said 2nd resist by supply of the acid from said 1st resist pattern The process which exfoliates the part of said 2nd resist non-constructing a bridge, and forms the 2nd resist pattern, and the process which etches said semi-conductor base material by using this 2nd resist pattern as a mask

[0010] Moreover, the manufacture approach of the semiconductor device concerning claim 6 of this invention is characterized by using said detailed pattern formation ingredient according to claim 1 to 4 as said 2nd resist.

[0011] Moreover, the manufacture approach of the semiconductor device concerning claim 7 of this invention is characterized by controlling reacting weight with said 1st resist by adjusting the amount of

mixing of said water soluble resin and said water-soluble cross linking agent, using said detailed pattern formation ingredient according to claim 3 as said 2nd resist.

[0012] Moreover, the manufacture approach of the semiconductor device concerning claim 8 of this invention is characterized by controlling reacting weight with said 1st resist by adjusting the degree of acetalization of said polyvinyl acetal as the 2nd resist using said detailed pattern formation ingredient according to claim 3 which used the polyvinyl acetal as water soluble resin.

[0013] Moreover, the manufacture approach of the semiconductor device concerning claim 9 of this invention is characterized by forming said bridge formation film in contact with the front face of said 1st resist pattern by heat-treating said 1st resist pattern and said 2nd resist formed on said 1st resist pattern.

[0014] Moreover, the manufacture approach of the semiconductor device concerning claim 10 of this invention is characterized by forming said bridge formation film in said predetermined field of said 1st resist pattern by exposing a predetermined field from on said 2nd resist formed on said 1st resist pattern and said 1st resist pattern.

[0015] Moreover, the manufacture approach of the semiconductor device concerning claim 11 of this invention carries out electron beam irradiation of except for the predetermined field of said 1st resist pattern, and is characterized by forming said 2nd resist on this 1st resist pattern by which electron beam irradiation was carried out, and forming said bridge formation film in said predetermined field of said 1st resist pattern.

[0016] Moreover, the semiconductor device concerning claim 12 of this invention is characterized by manufacturing by the manufacture approach of each aforementioned semiconductor device.

[0017]

[Embodiment of the Invention] Gestalt 1. drawing 1 of operation is drawing showing the example of the mask pattern for forming the target resist pattern by which detailed separation was carried out by this invention, in drawing 1 (a), the mask pattern 100 of a detailed hole and drawing 1 (b) show the mask pattern 200 of a detailed tooth space, and drawing 1 (c) shows the pattern 300 of the remnants of isolation. Drawing 2 - drawing 7 are the process-flow Figs. for explaining the detailed separation resist pattern formation approach of the gestalt 1 implementation this invention.

[0018] First, the detailed separation resist pattern formation approach of the gestalt this operation and the manufacture approach of the semiconductor device using this are explained, referring to drawing 1 and drawing 2. First, as drawing 2 (a) shows, the 1st resist 1 which has the device in which an acid is generated inside by suitable heat-treatment in the semi-conductor substrate (semi-conductor wafer) 3 is applied (about 0.7-1.0 micrometers in for example, thickness). This 1st resist 1 is applied with a spin coat etc. on the semi-conductor substrate 3, next gives Puri \*\* -KU (it is heat treatment for about 1 minute at 70-110 degrees C), and evaporates the solvent in the 1st resist 1.

[0019] Next, in order to form the 1st resist pattern, g line, i line or Deep-UV, a KrF excimer, an ArF excimer, EB (electron ray), X-ray, etc. carry out projection exposure using the mask containing a pattern as shown in drawing 1 using the light source corresponding to the sensibility wavelength of the 1st applied resist 1.

[0020] Either a positive type or negative resist is [ that what is necessary is just a resist using the device which an acidic component generates inside a resist by suitable heat-treatment ] OK as the ingredient of the 1st resist 1 used here. For example, as the 1st resist, the positive resist which consists of mixture of novolak resin and a naphthoquinonediazide system sensitization agent is mentioned. Furthermore, as the 1st resist, application of the chemistry magnification mold resist using the device in which an acid is generated may also be possible, and other things may be used as long as it is a resist ingredient using the system of reaction which generates an acid with heating.

[0021] After exposing the 1st resist 1, if needed, PEB (exposure afterbaking) is performed (for example, PEB temperature: 50-130 degrees C), and the resolution of a resist 1 is raised. Next, negatives are developed using about 0.05 to 3.0 wt% [ , such as TMAH (tetramethylammonium hydroxide), ] alkali water bath liquid. Drawing 2 (b) shows 1st resist pattern 1a formed in this way.

[0022] After performing a development, postdeveloping BEKU may be performed if needed (baking temperature is 60-120 degrees C and about 60 seconds). Since this heat treatment influences a next



mixing reaction, it is desirable to combine with the 1st resist to be used or the 2nd resist ingredient, and to set it as suitable temperature. The above is the same as that of formation of the resist pattern by the general resist process as a process, if the point of using the 1st resist 1 which generates an acid is set aside.

[0023] Next, as shown in drawing 2 (c), the ingredient of cross-linking which constructs a bridge by existence of an acid on the semi-conductor substrate 3 is used as a principal component, and the 2nd resist 2 dissolved in the solvent which does not dissolve the resist 1 of drawing 1 is applied. If spreading to homogeneity is possible for the method of application of the 2nd resist 2 on 1st resist pattern 1a, it can also be applied by not being limited especially and immersed into spreading by the spray, rotation spreading, or the 2nd resist solution (dipping). Next, this is prebaked after spreading of the 2nd resist 2 if needed (for example, 85 degrees C, about 60 seconds), and the 2nd resist layer 2 is formed.

[0024] Next, as shown in drawing 2 (d), 1st resist pattern 1a formed in the semi-conductor substrate 1 and the 2nd resist 2 formed on this are heat-treated (it is written as MB mixing BEKU and if needed [ following ]). 85 degrees C - 150 degrees C whenever [ stoving temperature ] is carried out, for example, diffusion of an acid is promoted from the 1st resist pattern 1a, it supplies into the 2nd resist 2, and crosslinking reaction is generated in the interface of the 2nd resist 2 and 1st resist pattern 1a. What is necessary is for the mixing baking temperature / time amount in this case to be 85 degree-C-150 degree-C/60-120sec(s), and just to set it as the optimal conditions with the class of resist ingredient to be used, and the thickness of the reaction layer to need. It is formed into the 2nd resist 2 so that the bridge formation layer 4 which caused crosslinking reaction may cover 1st resist pattern 1a with this mixing BEKU.

[0025] Next, as shown in drawing 2 (e), development exfoliation of the 2nd resist 2 which is not constructing a bridge is carried out using the developer of alkali water solutions, such as water or TMAH, and 2nd resist pattern 2a is formed. It becomes possible to obtain the resist pattern to which the hole bore of a hole pattern or the separation width of face of the Rhine pattern was reduced, or the area of an isolated remnants pattern was expanded by the above processing. \*\*.

[0026] In the above, by the formation approach of the detailed resist pattern explained with reference to drawing 2, after forming the 2nd resist layer 2 on 1st resist pattern 1a, the acid was generated in 1st resist pattern 1a by suitable heat-treatment, and how to diffuse to the 2nd resist 2 was explained. Below, instead of this heat-treatment, how to make an acid emit by exposure is explained in advance of heat-treatment. Drawing 3 is a process-flow Fig. for explaining the formation approach of the detailed separation resist pattern in this case. First, since the process of drawing 3 (a) - (c) is the same as that of drawing 2 (a) - (c), it omits explanation. In addition, as the 1st resist 1, application of the chemistry magnification mold resist using the device in which an acid is generated by exposure is also possible in this case. In a chemistry magnification mold resist, the magnification reaction which the generation reaction of the acid catalyst by light, an electron ray, an X-ray, etc. occurs, and is triggered by the catalyst of the generated acid is used.

[0027] Next, as shown in drawing 3 (d), the semi-conductor substrate 3 is again exposed completely by g line or i line of Hg lamp, an acid is generated in 1st resist pattern 1a, and after forming the 2nd resist layer 2 shown by drawing 3 (c), this forms the bridge formation layer 4 near the interface of the 2nd resist 2 which touches 1st resist pattern 1a, as shown in drawing 3 (e).

[0028] What is necessary is the light source used for the exposure at this time to be possible also for using Hg lamp, a KrF excimer, an ArF excimer, etc., and not to be limited by exposure especially if generating of an acid is possible for it, and just to expose it using the light source and light exposure according to the sensitization wavelength of the 1st used resist 1 according to the sensitization wavelength of the 1st resist 1.

[0029] Thus, it exposes after spreading of the 2nd resist 2, and an acid is generated in 1st resist pattern 1a, and by adjustment of light exposure, since the amount of the acid generated in 1st resist pattern 1a in order to expose 1st resist pattern 1a in the condition of having been covered with the 2nd resist 2 is correctly controllable in the large range, the thickness of the reaction layer 4 can control it with a sufficient precision by the example of drawing 3.

[0030] Next, the semi-conductor substrate 3 is heat-treated if needed (for example, 60-130 degrees C, mixing BEKU). By this, the acid from the 1st resist pattern 1a is diffused, it supplies into the 2nd resist 2, and crosslinking reaction is promoted in the interface of the 2nd resist 2 and 1st resist pattern 1a. What is necessary is for the mixing baking temperature / time amount in this case to be 60-130 degree-C/60-120sec(s), and just to set it as the optimal conditions with the class of resist ingredient to be used, and the thickness of the reaction layer to need. It is formed into the 2nd resist 2 so that the bridge formation layer 4 which caused crosslinking reaction may cover 1st resist pattern 1a with this mixing BEKU.

[0031] Next, the process of drawing 3 (f) is the same as that of drawing 2 (e). It becomes possible to obtain the resist pattern to which a hole bore or the separation width of face of the Rhine pattern was reduced, or the area of an isolated remnants pattern was expanded by the above processing.

[0032] In addition, like the example of the approach explained with reference to drawing 3, the process which generates an acid component in 1st resist pattern 1a by exposure is suitable, when the 1st resist 1 and 2nd resist 2 to apply have comparatively low reactivity, when the thickness of the bridge formation layer to need is comparatively thick, or especially when equalizing crosslinking reaction.

[0033] Here, the ingredient used for the 2nd resist 2 is explained. As the 2nd resist, the independence of the water soluble resin of cross-linking or two or more kinds of those mixture can be used. Moreover, the independence of a water-soluble cross linking agent or two or more kinds of those mixture are used. Furthermore, the mixture of these water soluble resin and a water-soluble cross linking agent is used. When using mixture as the 2nd resist, those ingredient presentations are not limited by the 1st resist ingredient to apply or the set-up reaction condition that what is necessary is just to especially set up the optimal presentation.

[0034] As an example of the water-soluble-resin constituent used for the 2nd resist Polyacrylic acid as shown in drawing 4, a polyvinyl acetal, a polyvinyl pyrrolidone, Polyvinyl alcohol, polyethyleneimine, polyethylene oxide, A styrene-maleic-acid copolymer, polyvinyl amineresin, the poly allylamine, Oxazoline radical content water soluble resin, water-soluble melamine resin, a water-soluble urea-resin, If it is the constituent in which a water-soluble cross linking agent and mixing are possible when not producing the constituent which an alkyd resin, sulfonamide resin, etc. can apply effectively, and produces crosslinking reaction under acidic component existence, or crosslinking reaction, it will not be limited especially. Moreover, it is effective even if it uses these independently, and it uses as mixture.

[0035] You may use as one kind or two kinds or more of mixture, and these water soluble resin can be suitably adjusted by reacting weight with the 1st resist 1 of a substrate, a reaction condition, etc. Moreover, it is the purpose which raises the solubility to water, and you may use by making these water soluble resin into salts, such as a hydrochloride.

[0036] Next, specifically as a water-soluble cross linking agent which can be used for the 2nd resist, amino system cross linking agents, such as melamine system cross linking agents, such as urea system cross linking agents, such as a urea as shown in drawing 5, alkoxy methyleneurea, N-alkoxy methyleneurea, an ethylene urea, and an ethylene urea carboxylic acid, a melamine, and an alkoxy methylene melamine, benzoguanamine, and glycoluryl, etc. are applicable. However, it will not be limited especially if it is the water-soluble cross linking agent which produces bridge formation not with the thing limited to especially an amino system cross linking agent but with an acid.

[0037] As a water-soluble concrete resist ingredient furthermore used for the 2nd resist, it is effective independent or independent or to also mix and use [ of water soluble resin which was mentioned above / of a water-soluble cross linking agent which was similarly mentioned above into mixture ] mixture mutually. For example, specifically, mixing and using a methoxy methylol melamine or an ethylene urea as a water-soluble cross linking agent as the 2nd resist, using polyvinyl-acetal resin as a water-soluble-resin constituent etc. is mentioned. In this case, since water solubility is high, the preservation stability of a mixed solution is excellent. In addition, it will not be limited especially if it is the ingredient which is meltable to water solubility or the water-soluble solvent which does not dissolve the 1st resist pattern as for the ingredient applied to the 2nd resist, and produces crosslinking reaction under existence of an acid component.

[0038] In addition, although it is as having explained previously that acid generating by the re-exposure to 1st resist pattern 1a is not performed, but crosslinking reaction can be realized only by heat-treatment, it is desirable to choose a suitable reactant high ingredient as the 2nd resist 2 in this case, and to perform suitable heat-treatment (for example, 85 degrees C - 150 degrees C). It is effective to specifically use the mixture of polyvinyl-acetal resin and an ethylene urea, the mixture of polyvinyl alcohol and an ethylene urea, or the water-soluble ingredient constituent that mixed these at a suitable rate as 2nd resist ingredient in this case.

[0039] Next, in this invention, it is important to control the crosslinking reaction of the 1st resist 1 and the 2nd resist 2, and to control the thickness of the bridge formation layer 4 formed on 1st resist pattern 1a. As for control of crosslinking reaction, it is desirable to optimize according to the reactivity of the 1st resist 1 and the 2nd resist 2 to apply, the configuration of 1st resist pattern 1a, the thickness of the crosslinking reaction layer 4 to need, etc.

[0040] Control of the crosslinking reaction of the 1st resist and the 2nd resist has the technique by adjustment of process conditions, and the technique of adjusting the presentation of the 2nd resist ingredient. as the process control technique of crosslinking reaction -- (1) -- the technique of adjusting (2) MB (mixing BEKU) temperature and the processing time which adjust the light exposure to 1st resist pattern 1a is effective. Especially, it heats, and by adjusting the time amount (MB time amount) which constructs a bridge, it is possible to control the thickness of a bridge formation layer, and it can be called the technique in which a reaction controllability is very high. Moreover, the technique of controlling reacting weight with the 1st resist from the field of the ingredient presentation used for the 2nd resist by mixing the suitable, water-soluble cross linking agent for (3) (4) which controls reacting weight with 1st resist by mixing two or more kinds of suitable water soluble resin, and adjusting the mixing ratio water soluble resin, and adjusting the mixing ratio is effective.

[0041] the thickness of the bridge formation layer which does not opt for control of such crosslinking reaction unitary, and (3) 3 [ the configuration of the reactivity of the 2nd resist ingredient and the 1st resist ingredient to apply, and the (1) (2) 1st resist pattern, thickness, and ] need and (4) -- it is necessary to take into consideration and determine conditions with various usable exposure conditions or MB conditions, (5) spreading conditions, etc. [ however, ] When, especially as for the reactivity of the 1st resist and the 2nd resist, the presentation of the 1st resist ingredient shows being influenced, therefore it actually applies this invention, it is desirable to take into consideration the factor mentioned above and to optimize the 2nd resist ingredient constituent. Therefore, especially the class and its presentation ratio of the water-soluble ingredient used for the 2nd resist are not limited, and are optimized and used according to the class of ingredient to be used, heat treatment conditions, etc.

[0042] In addition, plasticizers, such as ethylene glycol, a glycerol, and triethylene glycol, may be added to the 2nd resist ingredient with an additive. moreover, the 2nd resist ingredient -- being related -- a purpose [ top / membrane formation disposition ] -- carrying out -- the surfactant by 3M company, for example, Fluorad, and Mitsuhiro -- formation -- water-soluble surfactants, such as shrine NONIPORU, may be added as an additive.

[0043] Next, the solvent used for the 2nd resist is explained. Although it is required for the solvent used for the 2nd resist not to dissolve the pattern of the 1st resist and to fully dissolve a water-soluble ingredient further, it will not be limited especially if it is the solvent which fills this. For example, what is necessary is just to use the independence of water-soluble organic solvents, such as alcoholic solvent, such as water (pure water) or water, and IPA, or N-methyl pyrrolidone, or a mixed solution as a solvent of the 2nd resist.

[0044] What is necessary is it to be possible to use alcohols, such as ethanol, a methanol, and isopropyl alcohol, gamma-butyrolactone, an acetone, etc., and just to mix in the range which does not dissolve the 1st resist pattern as a solvent mixed in water, according to the solubility of the ingredient used for the 2nd resist, if it is water solubility, and it is not limited especially and an example is given.

[0045] Now, although the above example explained how to form a detailed resist pattern all over the semi-conductor substrate 3, how to form a detailed resist pattern alternatively only in the request field of the semi-conductor substrate 3 next is explained. Drawing 6 is the process-flow Fig. of the manufacture

approach in this case. First, the process of drawing 6 (a) - (c) is the same as that of drawing 3 (a) - (c). Like drawing 6 (c), after forming the 2nd resist layer 2 next, as shown in drawing 6 (d), it shades with a gobo 5, some semi-conductor substrates 3 are again exposed by g line or i line of Hg lamp to the selected field, and an acid is generated in 1st resist pattern 1a. This forms the bridge formation layer 4 near the interface of the 2nd resist 2 which touches 1st resist pattern 1a in the exposed part, as shown in drawing 6 (e).

[0046] Since the process of subsequent drawing 6 (f) is the same as the process of drawing 3 (f), explanation is omitted. Thus, in the field in which the semi-conductor substrate 3 was chosen, the bridge formation layer 4 is formed on 1st resist pattern 1a, and it can avoid forming a bridge formation layer in the 1st resist pattern in other fields, as shown in drawing 6 (f). According to such a formation approach, by using a suitable exposure mask, it can expose alternatively on the semi-conductor substrate 1, an exposure part and an unexposed part can be distinguished, and the 2nd resist pattern can form the field which constructs a bridge in a boundary part with the 1st resist pattern, and the field which does not construct a bridge. Thereby, the detailed hole or detailed tooth space of a different dimension on the same semi-conductor substrate can be formed.

[0047] Drawing 7 is the process-flow Fig. of other formation approaches for forming a detailed resist pattern alternatively only in the request field of the semi-conductor substrate 1. First, the process of drawing 7 (a) - (c) is the same as that of drawing 2 (a) - (c). Like drawing 7 (c), after forming the 2nd resist layer 2 next, as shown in drawing 7 (d), the field where the semi-conductor substrate 3 was chosen is covered with the electron ray shield 6, and an electron ray is irradiated to other fields. Next, if it heat-treats at the process of drawing 7 (e), a bridge formation layer will not be formed in the field which irradiated the electron ray, but a bridge formation layer will be formed only in the predetermined field which covered electron beam irradiation.

[0048] Since the process of subsequent drawing 7 (f) is the same as the process of drawing 2 (f), explanation is omitted. Thus, in the field in which the semi-conductor substrate 3 was chosen, the bridge formation layer 4 is formed on 1st resist pattern 1a, and it can avoid forming a bridge formation layer in the 1st resist pattern in other fields, as shown in drawing 7 (f). Thereby, the detailed hole or detailed tooth space of a different dimension on the same semi-conductor substrate can be formed.

[0049] As mentioned above, although the formation approach which forms a detailed separation resist pattern upwards at the semi-conductor substrate 3 was explained to the detail, the detailed separation resist pattern of this invention may not be restricted on the semi-conductor substrate 3, may be formed on insulating layers, such as silicon oxide, according to the manufacture process of a semiconductor device, and may be formed on conductive layers, such as polish recon film. Thus, formation of the detailed separation resist pattern of this invention is not restrained by the substrate film, if it is on the base material which can form a resist pattern, in which case, will be applicable and will be formed on a base material as occasion demands. Suppose that these are named generically and a semi-conductor base material is called.

[0050] Moreover, in this invention, semi-conductor base materials, such as a semi-conductor substrate of a substrate or various thin films, are etched by using as a mask the detailed separation resist pattern formed as mentioned above, a detailed tooth space or a detailed hole is formed in a semi-conductor base material, and a semiconductor device is manufactured. Moreover, it is effective in surface roughening of the base material pattern side-attachment-wall front face after etching being carried out by setting up appropriately the ingredient of the 2nd resist and an ingredient presentation, or MB temperature, and etching a semi-conductor base material by using as a mask the detailed separation resist pattern which formed the bridge formation layer on the 1st resist, and was obtained.

[0051] Gestalt 2. drawing 8 of operation is a process-flow Fig. for explaining the detailed separation resist pattern formation approach of the gestalt 2 implementation this invention. With reference to drawing 1 and drawing 8, the formation approach of the detailed separation resist pattern of the gestalt 2 this operation and the manufacture approach of the semiconductor device using this are explained.

[0052] First, as shown in drawing 8 (a), the 1st resist 11 which contains some acid inside is applied to the semi-conductor substrate 3. The 1st resist 11 carries out projection exposure using the mask

containing a pattern like drawing 1 using g line or i line of Hg lamp, after prebaking (it is heat treatment for about 1 minute at 70-100 degrees C) (it is omitting in drawing 8). Drawing 8 (b) shows 1st resist pattern 11a formed in this way. As an ingredient of the 1st resist 11 used here, what was explained with the gestalt 1 of operation is used effectively. The detailed explanation is omitted in order to avoid duplication. Moreover, specifically as an acid included in the 1st resist 11, the low-molecular acid of a carboxylic-acid system etc. is suitable.

[0053] Then, after heat-treating by PEB (10-130 degrees C) and raising the resolution of a resist if needed, negatives are developed using about 2.0% dilution water bath liquid of TMAH (tetramethylammonium hydroxide). Then, postdeveloping BEKU may be performed if needed. Since this heat treatment influences a next mixing reaction, it is necessary to set it as suitable temperature. The above is the same as that of formation of the resist pattern by the conventional resist process as a process, if the point of using the resist 11 containing an acid is set aside.

[0054] Next, as shown in drawing 8 (c) after the pattern formation of drawing 8 (b), the cross-linking ingredient which constructs a bridge by existence of an acid on the semi-conductor substrate 3 is used as a principal component, and the 2nd resist 12 melted by the solvent which does not dissolve the 1st resist 11 is applied. The ingredient of the 2nd resist 12 used here and its solvent can apply what was stated with the gestalt 1 of operation, and the same thing, and are effective. The detailed explanation is omitted in order to exclude duplication. . Next, this is prebaked after spreading of the 2nd resist 12 if needed. Since this heat treatment influences a next mixing reaction, it is desirable to set it as suitable temperature.

[0055] Next, the semi-conductor substrate 3 is heat-treated (60-130 degrees C), and crosslinking reaction is made to cause near the interface with 1st resist pattern 11a of the 2nd resist 12 by supply of the acid from some acid contained in 1st resist pattern 11a, as shown in drawing 8 (d). The bridge formation layer 14 which caused crosslinking reaction by this so that 1st resist pattern 11a might be covered is formed into the 2nd resist 12.

[0056] Next, as shown in drawing 8 (e), development exfoliation of the part over which the 2nd resist 12 is not constructing a bridge using developers, such as water or TMAH, is carried out. It becomes possible to obtain the resist pattern which reduced the hole bore of a hole pattern, or the separation width of face of the Rhine pattern, or the resist pattern to which the area of an isolated remnants pattern was expanded by the above processing.

[0057] As mentioned above, the 1st resist 11 in the gestalt 2 of this operation does not have the need of generating an acid by exposure, and it diffuses that acid by heat treatment, and he is trying to make it it to be adjusted so that an acid may be included in resist film 11 the very thing, and construct a bridge. As an acid included in this 1st resist 11, although the low-molecular acid of a carboxylic-acid system etc. is suitable, if mixing in a resist solution is possible, especially limitation will not be carried out.

[0058] Moreover, it is the same as that of the gestalt 1 of the operation described previously to form this detailed separation resist pattern on various kinds of semi-conductor base materials, and to form [ hole / a detailed separation tooth space or / detailed ] it on a semi-conductor base material, using this as a mask.

[0059] Gestalt 3. drawing 9 of operation is a process-flow Fig. for explaining the formation approach of the detailed separation resist pattern of the gestalt 3 implementation this invention. With reference to drawing 1 and drawing 9, the formation approach of the detailed separation resist pattern of the gestalt 3 this operation and the manufacture approach of the semiconductor device using this are explained.

[0060] First, as shown in drawing 9 (a), the 1st resist 21 is applied to the semi-conductor substrate 3. After prebaking to the 1st resist 21 (it is heat treatment for about 1 minute at 70 to 100 degree C), projection exposure is carried out using the mask containing a pattern like drawing 1 using g line or i line of Hg lamp, corresponding to the sensitization wavelength of the 1st resist 21 (illustration is omitted in drawing 9). As an ingredient of the 1st resist 21 used here, what was explained with the gestalt 1 of operation is used effectively. The detailed explanation is omitted in order to avoid duplication.

[0061] Next, after it heat-treats by PEB (10-130 degrees C) and a resist carries out improvement in resolution if needed, negatives are developed using about 2.0% dilution water solution of TMAH

(tetramethylammonium hydroxide). Drawing 9 (b) shows pattern 21a of the 1st resist formed in this way. Then, postdeveloping BEKU may be performed if needed. Since this heat treatment influences a next mixing reaction, it is necessary to set it as suitable temperature. The above is the same as that of formation of the resist pattern by the conventional resist process as a process.

[0062] As shown after the pattern formation of drawing 9 (b), next in drawing 9 (c), immersion processing of the semi-conductor substrate 3 is carried out with an acidic solution. The art is good in the method of the usual paddle development. Moreover, you may carry out by the vapor rise (blasting) of an acidic solution. Moreover, surface treatment may be carried out by the sour gas. Any of an organic acid and an inorganic acid are sufficient as the acidic solution or sour gas in this case. Specifically, a low-concentration acetic acid is mentioned as a suitable example. In this process, an acid sinks in near the interface of 1st resist pattern 21a, and the film containing an acid is formed. Then, a rinse is carried out using pure water if needed.

[0063] Then, as shown in drawing 9 (e), the cross-linking ingredient which constructs a bridge by existence of an acid on the 1st resist pattern 21 is used as a principal component, and the 2nd resist 22 melted by the solvent which does not dissolve the 1st resist 21 is applied. What has the ingredient of the 2nd resist 22 used here and its solvent be [ the same as that of what was stated with the gestalt 1 of operation ] it is used effectively. In order to avoid duplication, the detailed explanation is omitted. Next, the 2nd resist 22 is prebaked after spreading of the 2nd resist 22 if needed. Since this heat treatment influences a next mixing reaction, it is set as suitable temperature.

[0064] Next, the semi-conductor substrate 3 is heat-treated (60-130 degrees C), bridge formation BEKU is performed, and crosslinking reaction is made to cause by supply of the acid from the 1st resist pattern 21a near the interface with 1st resist pattern 21a of the 2nd resist 22, as shown in drawing 9 (f). The bridge formation layer 24 which caused crosslinking reaction by this so that 1st resist pattern 21a might be covered is formed into the 2nd resist 22.

[0065] Next, as shown in drawing 9 (g), development exfoliation of the part over which the 2nd resist 22 is not constructing a bridge using developers, such as water or TMAH, is carried out. It becomes possible to obtain the resist pattern which reduced the hole bore of a hole pattern, or the separation width of face of the Rhine pattern by the above processing.

[0066] As mentioned above, before not needing the process which generates an acid for the 1st resist but forming the 2nd resist 22 on 1st resist pattern 21a by exposure processing, surface treatment by the acid liquid or the sour gas is performed, and an acid is diffused by heat treatment at a next process, and it is made to construct a bridge according to the gestalt 3 of this operation.

[0067] Moreover, it is the same as that of the gestalten 1 and 2 of the operation described previously to form the detailed separation resist pattern which carried out in this way and was formed on various kinds of semi-conductor substrates, to form a detailed separation tooth space or a detailed detailed hole etc. on a semi-conductor substrate by making this into a mask, and to manufacture a semiconductor device.

[0068]

[Example] Next, the example relevant to the gestalten 1-3 of each aforementioned operation is explained. Since one example may be related to the gestalt of one or more operations, it explains collectively. First, the examples 1-5 about the 1st resist ingredient are explained.

As the example 1. 1st resist, it consisted of novolak resin and naphthoquinonediazide and the resist pattern was formed using i line resist using ethyl lactate and propylene glycol monoethyl acetate as a solvent. First, said resist was dropped on Si wafer, after carrying out rotation spreading, it prebaked in 85 degrees C / 70 seconds, the solvent in a resist was evaporated, and the 1st resist was formed by about 1.0 micrometers of thickness. Next, the 1st resist was exposed as an exposure mask using the mask as shown in drawing 1, using i line contraction projection aligner as an aligner. Next, PEB processing was performed in 120 degrees C / 70 seconds, then negatives were developed using the alkali developer (the TOKYO OHKA KOGYO CO., LTD. make, NMD3), and the resist pattern with separation size as shown in drawing 10 was obtained.

[0069] As the example 2. 1st resist, it consisted of novolak resin and naphthoquinonediazide and the resist pattern was formed using i line resist using 2-heptanone as a solvent. First, said resist was formed

so that it might become about 0.8 micrometers of thickness by dropping and rotation spreading on Si wafer. Next, it prebaked in 85 degrees C / 70 seconds, and the solvent in a resist was dried. Then, it exposed using the mask as shown in drawing 1 using i line contraction projection aligner. Next, PEB processing was performed in 120 degrees C / 70 seconds, then negatives were developed using the alkali developer (Tokyo adaptation shrine make, NMD3), and the resist pattern with separation size as shown in drawing 10 was obtained.

[0070] As the example 3. 1st resist, it consisted of novolak resin and naphthoquinonediazide and the resist pattern was formed using i line resist using the mixed solvent of ethyl lactate and butyl acetate as a solvent. First, said resist was formed so that it might become about 1.0 micrometers of thickness by dropping and rotation spreading on Si wafer. Next, it prebaked in 100 degrees C / 90 seconds, and the solvent in a resist was dried. Then, it exposed using the mask as shown in drawing 1 using SUTEBBA by NIKON CORP. Next, PEB processing was performed in 110 degrees C / 60 seconds, then negatives were developed using the alkali developer (Tokyo adaptation shrine make, NMD3), and the resist pattern as shown in drawing 10 was obtained.

[0071] as the example 4. 1st resist -- Tokyo -- adaptation -- the resist pattern was formed using the shrine chemistry magnification mold excimer resist. First, said resist was formed so that it might become about 0.8 micrometers of thickness by dropping and rotation spreading on Si wafer. Next, it prebaked in 90 degrees C / 90 seconds, and the solvent in a resist was dried. Then, it exposed using the mask as shown in drawing 1 using the KrF excimer contraction projection aligner. Next, PEB processing was performed in 100 degrees C / 90 seconds, then negatives were developed using the alkali developer (Tokyo adaptation shrine make, NMD-W), and the resist pattern as shown in drawing 11 was obtained.

[0072] As the example 5. 1st resist, the resist pattern was formed using the chemistry magnification mold resist (2773 MELKER, J.Vac.Sci.Technol., B11 (6) 1993) by Ryoden Kasei CO., LTD. which consists of t-Boc-ized polyhydroxy styrene and an acid generator. First, said resist was formed so that it might become about 0.52 micrometers of thickness by dropping and rotation spreading on Si wafer. Next, \*\*--KU was performed in 120 degrees C / 180 seconds, and the solvent in a resist was dried. then, this resist top -- as the antistatic film -- the Showa Denko K.K. make -- after carrying out rotation spreading of S pay sir ESP-100 similarly, \*\*--KU was performed in 80 degrees C / 120 seconds. Next, it drew by 17.4microC/cm2 using EB drawing equipment. Next, after performing PEB in 80 degrees C / 120 seconds, pure water was used, and the resist pattern was continuously exfoliation and developed using the TMAH alkali developer (Tokyo adaptation shrine NMD-W) in the antistatic film.

Consequently, about 0.2-micrometer EB resist pattern as shown in drawing 12 was obtained.

[0073] Next, the examples 6-13 about the 2nd resist ingredient are explained.

example 6. -- as the 2nd resist ingredient -- 1L measuring flask -- using -- 20wt% water-solution: of the polyvinyl-acetal resin S leks KW3 and KW1 by Sekisui Chemical Co., Ltd. -- pure-water:400g was added to 100g, respectively, stirring mixing was carried out at the room temperature for 6 hours, and the 5wt% water solution of polyvinyl-acetal resin KW3 and KW1 was obtained, respectively.

[0074] example 7. -- as 2nd resist ingredient, it replaced with the polyvinyl-acetal resin of an example 6, and each 5wt% water solution was obtained like the example 6 using polyvinyl alcohol resin, oxazoline content water soluble resin (the NIPPON SHOKUBAI Co., Ltd. make, the EPO cross WS 500), and a styrene maleic anhydride copolymer (the product made from ARCOchemical, SMA 1000 and 1440H).

[0075] example 8. -- using 1L measuring flask as 2nd resist ingredient, stirring mixing of methoxy methylol melamine (product [ made from Mitsui SAINAMIDO ], Cymel 370):100g, pure-water:780g, and the IPA:40g was carried out at the room temperature for 6 hours, and the about 10 wt(s)% methylol melamine water solution was obtained.

[0076] example 9. -- using 1L measuring flask as 2nd resist ingredient, in methoxy (N-methoxymethyl) ethylene urea:100g, hydroxy (N-methoxymethyl) ethylene urea:100g, and N-methoxymethyl urea:100g, stirring mixing of pure-water:860g and the IPA:40g was carried out at the room temperature for 6 hours, and the about 10 wt(s)% ethylene urea water solution was obtained, respectively.

[0077] example 10. -- stirring mixing of KW3 water-solution:160g of the polyvinyl acetal obtained in the example 6 and methoxy methylol melamine water-solution:20g obtained in the example 8 and the



pure-water:20g was carried out at the room temperature as 2nd resist ingredient for 6 hours, and water soluble resin and the mixed solution of a water-soluble cross linking agent were obtained.

[0078] example 11. -- as 2nd resist ingredient, in KW3 water-solution:160g of the polyvinyl acetal obtained in the example 6, methoxy (N-methoxymethyl) ethylene urea water-solution:20g obtained in the example 9, hydroxy (N-methoxymethyl) ethylene urea water-solution:20g, and N-methoxymethyl urea water-solution:20g, stirring mixing of the pure-water:20g was carried out at the room temperature for 6 hours, and water soluble resin and the mixed solution of a water-soluble cross linking agent were obtained, respectively.

[0079] example 12. -- each was mixed for KW3 water-solution:160g of the polyvinyl acetal obtained in the example 6, and 10g, 20g, 30g of the methoxy ethylene urea water solution obtained in the example 9, and pure-water:20g under the room temperature as 2nd resist ingredient for 6 hours. Consequently, the concentration of the methoxy ethylene urea which is a water-soluble cross linking agent to polyvinyl-acetal resin obtained three kinds of 2nd 27wt% resist water solution 20wt% about 1 lwt%.

[0080] As the example 13. 2nd resist, stirring mixing of the 5wt% water solution of polyvinyl alcohol resin was carried out under the room temperature by mixing 0g, 35.3g, and 72.2g for 6 hours among the water-soluble-resin solutions obtained in the example 7 to 100g of the 5wt(s)% polyvinyl-acetal resin water solution obtained in the example 6, and three kinds of mixed solutions with which the mixing ratios of polyvinyl-acetal resin and polyvinyl alcohol resin differ were obtained.

[0081] Next, the examples 14-22 of detailed resist pattern formation are explained.

On Si wafer with which the 1st resist pattern obtained in the example 14. example 3 was formed, after dropping and carrying out the spin coat of the 2nd resist ingredient obtained in the example 12, it prebaked in 85 degrees C / 70 seconds, and the 2nd resist film was formed. Next, mixing BEKU (MB) was performed in 120 degrees C / 90 seconds, and crosslinking reaction was advanced. Next, by developing negatives using pure water, carrying out development exfoliation of the layer non-constructing a bridge, and performing postbake in next 90 degrees C / 90 seconds, the 2nd resist bridge formation layer was formed on the 1st resist pattern, and as shown in drawing 13, the 2nd resist pattern was formed. In drawing 13, the mixing ratio of water soluble resin was changed by having made the diameter of a hole of the 2nd resist pattern into the length measurement location, and the resist pattern size after the bridge formation stratification was measured. This result is shown in the table of drawing 14. In this case, by changing the amount of mixing of polyvinyl-acetal resin and polyvinyl alcohol resin shows that it is possible to control the thickness of the bridge formation layer formed on the 1st resist.

[0082] On Si wafer with which the 1st resist pattern obtained in the example 15. example 2 was formed, after the resin water solution of KW1 obtained in the example 6 was dropped as 2nd resist ingredient and carried out the spin coat, it prebaked in 85 degrees C / 70 seconds, and the 2nd resist film was formed. Next, complete exposure was performed to the wafer using i line aligner. Furthermore, mixing BEKU (MB) was performed in 150 degrees C / 90 seconds, and crosslinking reaction was advanced. Next, negatives were developed using pure water, development exfoliation of the layer non-constructing a bridge was carried out, and the 2nd resist bridge formation layer was formed on the hole pattern which is the 1st resist pattern like what was shown in drawing 13 by performing postbake in 110 degrees C / 90 seconds continuously. The resist pattern size after the bridge formation stratification was measured about the case where it does not consider as the case where complete exposure is carried out by making into a length measurement location the diameter of a hole of the 2nd resist pattern shown in drawing 13. This result is shown in the table of drawing 15. When the 1st resist hole pattern size of 0.4 micrometers before forming a bridge formation layer performed complete exposure by this and about 0.14 micrometers and complete exposure were not performed, it was reducing by about 0.11 micrometers. In this case, by performing complete exposure before MB \*-KU, compared with the case where it does not carry out, crosslinking reaction advanced more and the bridge formation layer was thickly formed in the 1st resist front face.

[0083] On Si wafer with which the 1st resist pattern obtained in the example 16. example 2 was formed, the mixed solution of the polyvinyl-acetal resin obtained in the example 11 and an ethylene urea was used as the 2nd resist. After dropping and carrying out the spin coat of the 2nd resist ingredient, it



prebaked in 85 degrees C / 70 seconds, and the 2nd resist film was formed. Next, for 105 degrees C / 90 seconds, for 115 degrees C / 90 seconds, mixing BEKU (MB) was performed on three kinds of conditions for 125 degrees C / 90 seconds, and crosslinking reaction was performed. Next, negatives were developed using pure water and development exfoliation of the non-cross linking agent was carried out, and by performing postbake in 90 degrees C / 90 seconds continuously, as shown in drawing 16, the 2nd resist bridge formation layer was formed on the 1st resist pattern. The temperature of mixing BEKU (MB) was changed by having made into the length measurement location the tooth space in the diameter of a hole, the Rhine pattern, and isolated remnants pattern of the 2nd resist pattern shown in drawing 16, and the resist pattern size after the bridge formation stratification was measured. This result is shown in the table of drawing 17. Consequently, with the resist pattern after the bridge formation stratification, the size of the tooth space in the bore of a hole pattern, and the Rhine pattern and an isolated remnants pattern of 0.4-micrometer size formed in the example 2 is reduced, as shown in drawing 17, and the amount of contraction is increasing while MB temperature becomes high. From this, the temperature control of MB shows that control of crosslinking reaction is possible with a sufficient precision.

[0084] On Si wafer with which the 1st resist pattern obtained in the example 17. example 3 was formed, the mixed solution from which the concentration of an ethylene urea differs with the polyvinyl-acetal water solution obtained in the example 6, the polyvinyl-acetal resin obtained in the example 12 and an ethylene urea mixed water solution, and polyvinyl alcohol resin and an ethylene urea mixed water solution was used as the 2nd resist. After dropping and carrying out the spin coat of the 2nd resist ingredient, it prebaked in 85 degrees C / 70 seconds, and the 2nd resist film was formed. Next, mixing BEKU (MB) was performed in 65 degrees C / 70 +100 degrees C / per second, and 90 seconds, and crosslinking reaction was performed. Next, negatives were developed using pure water, development exfoliation of the layer non-constructing a bridge was carried out, and the 2nd resist bridge formation layer was formed on the 1st resist pattern like what was shown in drawing 13 by performing postbake in 90 degrees C / 90 seconds continuously. The amount of mixing of a water-soluble cross linking agent was changed by having made into the length measurement location the diameter of a hole of the 2nd resist pattern shown in drawing 13, and the resist pattern size after the bridge formation stratification was measured. This result is shown in the table of drawing 18. Consequently, the bore of the hole pattern of about 0.4-micrometer size formed in the example 3 is reduced as shown in drawing 18, and the amount of contraction becomes so large that the amount of mixing of a water-soluble cross linking agent increases. From this, by adjusting the mixing ratio of a water-soluble ingredient shows that control of crosslinking reaction is possible with a sufficient precision. Moreover, but by [ with the same amount of cross linking agents ] changing the class of water soluble resin shows that it is possible to control the amount of contraction.

[0085] On Si wafer with which the 1st resist pattern obtained in the example 18. example 3 was formed, the polyvinyl-acetal water solution obtained in the example 6, the polyvinyl-acetal resin water solution obtained in the example 11, and the mixed solution of the N-methoxymethyl-methoxy ethylene urea mixed water solution which is a water-soluble cross linking agent, a hydroxy (N-methoxymethyl) ethylene urea, and N-methoxymethyl urea were used as the 2nd resist. After dropping and carrying out the spin coat of the 2nd resist ingredient, it prebaked in 85 degrees C / 70 seconds, and the 2nd resist film was formed. Next, mixing BEKU (MB) was performed in 65 degrees C / 70 +100 degrees C / per second, and 90 seconds, and crosslinking reaction was performed. Next, negatives were developed using pure water, development exfoliation of the layer non-constructing a bridge was carried out, and the 2nd resist bridge formation layer was formed on the 1st resist pattern like what was shown in drawing 13 by performing postbake in 90 degrees C / 90 seconds continuously. The water-soluble cross linking agent was changed by having made into the length measurement location the diameter of a hole of the 2nd resist pattern shown in drawing 13, and the resist pattern size after the bridge formation stratification was measured. This result is shown in the table of drawing 19. Consequently, the bore of the hole pattern of about 0.4-micrometer size formed in the example 3 is reduced as shown in drawing 19, and as for the amount of contraction, a difference is accepted by the difference in a water-soluble cross linking agent. From this, the difference in the class of water-soluble ingredient to mix shows that control of

crosslinking reaction is possible.

[0086] On Si wafer with which the 1st resist pattern obtained in the example 19. example 4 was formed, the polyvinyl-acetal water solution obtained in the example 6, and the polyvinyl-acetal resin water solution obtained in the example 11 and the methoxy ethylene urea mixed water solution which is a water-soluble cross linking agent were used as the 2nd resist. After dropping and carrying out the spin coat of the 2nd resist ingredient, it prebaked in 85 degrees C / 70 seconds, and the 2nd resist film was formed. Next, mixing BEKU for 90 seconds (MB) was performed at predetermined temperature, and crosslinking reaction was performed. Next, negatives were developed using pure water, development exfoliation of the layer non-constructing a bridge was carried out, and the 2nd resist bridge formation layer was formed on the 1st resist pattern like what was shown in drawing 13 by performing postbake in 90 degrees C / 90 seconds continuously. The amount of a water-soluble cross linking agent and reaction temperature were changed by having made into the length measurement location the diameter of a hole of the 2nd resist pattern shown in drawing 13, and the resist pattern size after the bridge formation stratification was measured. This result is shown in the table of drawing 20. Consequently, the resist pattern size of about 0.3 micrometers formed in the example 4 is reduced as shown in drawing 20, and a difference is accepted with the amount of water-soluble cross linking agents, and reaction temperature. Also when the chemistry magnification mold resist which generates an acid by optical exposure is used from this, it turns out that control of the resist pattern size by crosslinking reaction is possible.

[0087] On Si wafer with which the 1st resist pattern obtained in the example 20. example 5 was formed, the polyvinyl-acetal water solution obtained in the example 6, and the polyvinyl-acetal resin water solution obtained in the example 11 and the methoxy ethylene urea mixed water solution which is a water-soluble cross linking agent were used as the 2nd resist. After dropping and carrying out the spin coat of the 2nd resist ingredient, it prebaked in 85 degrees C / 70 seconds, and the 2nd resist film was formed. Next, mixing BEKU (MB) was performed in 105 or 115 degrees C / 90 seconds, and crosslinking reaction was performed. Next, negatives were developed using pure water and development exfoliation of the layer non-constructing a bridge was carried out, and by performing postbake in 90 degrees C / 90 seconds continuously, as shown in drawing 13, the 2nd resist bridge formation layer was formed on the 1st resist pattern. The amount of a water-soluble cross linking agent and reaction temperature were changed by having made into the length measurement location the diameter of a hole of the 2nd resist pattern shown in drawing 13, and the resist pattern size after the bridge formation stratification was measured. This result is shown in the table of drawing 21. Consequently, the size of the resist pattern of about 0.2-micrometer size formed in the example 5 is reduced as shown in drawing 21, and as for the amount of contraction, a difference is accepted by the difference in a water-soluble ingredient, and the difference in MB temperature. Also when EB resist of the chemistry magnification mold which consists of t-Boc-ized polyhydroxy styrene and an acid generator is used from this, it turns out that control of the resist pattern size by crosslinking reaction is possible.

[0088] On the 1st resist pattern obtained in the example 21. example 2, the electron ray was irradiated alternatively. The exposure of an electron ray irradiated 50microC/cm2. Next, the polyvinyl-acetal resin water solution obtained in the example 11 and the methoxy ethylene urea mixed water solution which is a water-soluble cross linking agent were applied as the 2nd resist on the 1st resist pattern which irradiated the electron ray. Spreading trickled the 2nd resist ingredient, and performed the spin coat, then prebaked in 85 degrees C / 70 seconds, and formed the 2nd resist film. Furthermore, mixing BEKU (MB) was performed in 120 degrees C / 90 seconds, and crosslinking reaction was performed. The 2nd resist bridge formation film was alternatively formed on the 1st resist pattern like what was shown in drawing 13 by developing negatives by using pure water finally, carrying out development exfoliation of the layer non-constructing a bridge, and performing postbake in next 110 degrees C / 70 seconds. The resist pattern size after the bridge formation stratification was measured about the exposure part of an electron ray, and the non-irradiated part by making into a length measurement location the diameter of a hole of the 2nd resist pattern shown in drawing 13. This result is shown in the table of drawing 22. Consequently, in the part which did not irradiate an electron ray, about 0.4-micrometer resist pattern formed in the example 2 was reduced, as shown in drawing 22, about the part which irradiated the

electron ray alternatively, crosslinking reaction did not occur and contraction of hole size was not seen. By the pattern of the part irradiated by irradiating an electron ray alternatively after forming a resist pattern from this, since a reaction does not arise, it turns out that size control of an alternative resist pattern is possible.

[0089] The 1st resist pattern obtained in the example 22. example 2 was formed on Si wafer with which the oxide film was formed, and the 1st resist pattern as shown in drawing 23 was formed. Next, after dropping and carrying out the spin coat of the 2nd resist ingredient obtained in the example 12 and prebaking in 85 degrees C / 70 seconds, the 2nd resist bridge formation layer was formed on the 1st resist pattern by carrying out development exfoliation of the layer non-constructing a bridge with pure water, performing mixing BEKU in 105 degrees C / 90 seconds, and performing postbake in 90 degrees C / 90 seconds continuously. Furthermore, the substrate oxide film was etched using the etching system, and the pattern configuration after etching was observed. Moreover, it etched similarly about the wafer in which the 1st resist pattern shown in drawing 23 which does not process this invention as an example of a comparison was formed. Consequently, while separation width of face was reduced as shown in drawing 24 (b) and (c) when this invention was applied as compared with drawing 24 (a) when not applying this invention, the oxide-film pattern with which surface roughening of the side attachment wall was carried out was obtained. Moreover, it turns out that extent of surface roughening is controllable by the amount of mixing of a cross linking agent.

[0090] In addition, this application also includes the following invention besides invention indicated to the claim, as explained to the detail above. Other invention of this application is one kind in polyacrylic acid, a polyvinyl acetal, a polyvinyl pyrrolidone, polyvinyl alcohol, polyethyleneimine, polyethylene oxide, a styrene maleic anhydride copolymer, a polyvinyl amine, the poly allylamine, oxazoline radical content water soluble resin, water-soluble melamine resin, a water-soluble urea-resin, an alkyd resin, and a sulfonamide, or these two kinds or more of mixture, or a detailed pattern formation ingredient characterized by using these salts as a principal component as said water soluble resin in a thing according to claim 1.

[0091] Moreover, other invention of this application is detailed pattern formation ingredients characterized by using one kind or these two kinds or more of mixture of a melamine derivative, a urea derivative, benzoguanamine, and the glycoluril as a principal component as said water-soluble cross linking agent in a thing according to claim 2.

[0092] Moreover, other invention of this application is detailed pattern formation ingredients characterized by using one kind or such mixture of a melamine and the alkoxy methylene melamines as a principal component as said melamine derivative in a thing according to claim 2.

[0093] Moreover, other invention of this application is detailed pattern formation ingredients characterized by using one kind or these two kinds or more of mixture of a urea, alkoxy methyleneurea, N-alkoxy methyleneurea, an ethylene urea, and an ethylene urea carboxylic acid as a principal component as said urea derivative in a thing according to claim 2.

[0094] Moreover, other invention of this application is detailed pattern formation ingredients characterized by using either of the mixture of a melamine derivative, a urea derivative or a melamine derivative, and a urea derivative as said water-soluble cross linking agent, using either of the mixture of a polyvinyl acetal, polyvinyl alcohol or polyvinyl alcohol, and a polyvinyl acetal as said water soluble resin in a thing according to claim 3.

[0095] Moreover, other invention of this application is detailed pattern formation ingredients characterized by including a plasticizer as an additive in a thing according to claim 3.

[0096] Moreover, other invention of this application is the manufacture approaches of the semiconductor device characterized by forming said 1st resist pattern by the resist which generates an acid by heat-treatment in a thing according to claim 5.

[0097] Moreover, other invention of this application is the manufacture approaches of the semiconductor device characterized by forming said 1st resist pattern by the resist which generates an acid by exposure in a thing according to claim 5.

[0098] Moreover, other invention of this application is the manufacture approaches of the semiconductor

device characterized by forming said 1st resist pattern by the resist containing an acid in a thing according to claim 5.

[0099] Moreover, other invention of this application is the manufacture approaches of the semiconductor device characterized by forming said 1st resist pattern by the resist which performed surface preparation by the acid liquid or acid gases in a thing according to claim 5.

[0100] Moreover, other invention of this application is the manufacture approaches of the semiconductor device characterized by using the resist which uses novolak resin and mixture of a naphthoquinonediazide system sensitization agent as a principal component as said 1st resist in a thing according to claim 5.

[0101] Moreover, other invention of this application is the manufacture approaches of the semiconductor device characterized by using the chemistry magnification mold resist which has the device in which an acid is generated, as said 1st resist in a thing according to claim 5.

[0102] Moreover, other invention of this application is the manufacture approaches of the semiconductor device characterized by using water or a water-soluble mixed solvent as a solvent of said 2nd resist in a thing according to claim 8.

[0103]

[Effect of the Invention] As mentioned above, as explained to the detail, according to this invention, the charge of detailed separation resist pattern formation material which makes pattern formation exceeding a wavelength limitation possible, and the detailed pattern formation approach using it are acquired in detailed-izing of the separation pattern of a resist, and a hole pattern. Thereby, the diameter of a hole of a Hall system resist pattern can be reduced conventionally, and the separation width of face of a SU \*\*-SU system resist pattern can be reduced conventionally. moreover, the tooth space by which detailed separation was carried out on the semi-conductor base material, using as a mask the detailed separation resist pattern which carried out in this way and was formed -- or hole formation can be carried out. Moreover, the semiconductor device which has the tooth space or hole by which detailed separation was carried out by such manufacture approach can be obtained.

[Brief Description of the Drawings]

[Drawing 1] Drawing of the mask pattern for explaining the resist pattern formation approach of the gestalt 1 implementation this invention.

[Drawing 2] The process flow Fig. for explaining the resist pattern formation approach of the gestalt 1 implementation this invention.

[Drawing 3] The process flow Fig. for explaining the resist pattern formation approach of the gestalt 1 implementation this invention.

[Drawing 4] Drawing showing the example of the water-soluble-resin constituent used by the resist pattern formation approach of the gestalt 1 implementation this invention.

[Drawing 5] Drawing showing the example of the water-soluble cross linking agent used by the resist pattern formation approach of the gestalt 1 implementation this invention.

[Drawing 6] The process flow Fig. for explaining the resist pattern formation approach of the gestalt 1 implementation this invention.

[Drawing 7] The process flow Fig. for explaining the resist pattern formation approach of the gestalt 1 implementation this invention.

[Drawing 8] The process flow Fig. for explaining the resist pattern formation approach of the gestalt 2 implementation this invention.

[Drawing 9] The process flow Fig. for explaining the resist pattern formation approach of the gestalt 3 implementation this invention.

[Drawing 10] The 1st resist pattern in the examples 1, 2, and 3 of this invention.

[Drawing 11] The 1st resist pattern in the example 4 of this invention.

[Drawing 12] The 1st resist pattern in the example 5 of this invention.

[Drawing 13] The 2nd resist pattern in the example 14 of this invention.

[Drawing 14] Drawing showing the mixing ratio of the water soluble resin in the example 14 of this invention, and the resist pattern size after the bridge formation stratification.

[Drawing 15] Drawing showing the resist pattern size after the existence of the exposure in the example 15 of this invention, and the bridge formation stratification.

[Drawing 16] The 2nd resist pattern in the example 16 of this invention

[Drawing 17] Drawing showing the mixing baking temperature in the example 16 of this invention, and the resist pattern size after the bridge formation stratification.

[Drawing 18] Drawing showing the mixing ratio of the water-soluble ingredient in the example 17 of this invention, and the resist pattern size after the bridge formation stratification.

[Drawing 19] Drawing showing the resist pattern size after the class of water-soluble ingredient in the example 18 of this invention, and the bridge formation stratification.

[Drawing 20] Drawing showing the amount of the water-soluble ingredient in the example 19 of this invention, and mixing baking temperature and the resist pattern size after the bridge formation stratification.

[Drawing 21] Drawing showing the resist pattern size after the class of water-soluble ingredient in the example 20 of this invention, and the bridge formation stratification.

[Drawing 22] Drawing showing the resist pattern size after the existence of the electron beam irradiation in the example 21 of this invention, and the bridge formation stratification.

[Drawing 23] Drawing showing the 2nd resist pattern in the example 22 of this invention.

[Drawing 24] Drawing showing the pattern configuration after etching of the substrate oxide film in the example 22 of this invention.

[Description of Notations]

1, 11, 21 The 1st resist 1a, 2a, 3a The 1st resist pattern 2, 12, 22 The 2nd resist 2a, 12a, 22a The 2nd resist pattern 3 Semi-conductor substrate (semi-conductor base material) 4, 14, 24 Bridge formation layer.

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[Translation done.]